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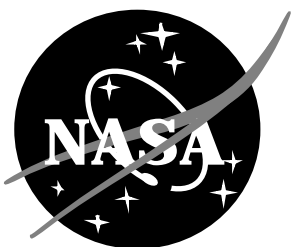
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ATTACHMENT A
#423-41-01**

**EOSDIS CORE SYSTEM
STATEMENT OF WORK**

(SOW)

16 February, 1993



GODDARD SPACE FLIGHT CENTER
GREENBELT, MD. _____

EOSDIS CORE SYSTEM (ECS)

— STATEMENT OF WORK—

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EOSDIS CORE SYSTEM (ECS)

— STATEMENT OF WORK —

SECTION 1 – INTRODUCTION

1.1 Overview

The National Aeronautics and Space Administration (NASA) is implementing a data system for the acquisition, processing, storage, and distribution of Earth observation data. This system, known as the Earth Observing System (EOS) Data and Information System (EOSDIS), will be used to support the EOS mission. The EOSDIS will be a geographically distributed system which will support the operation and management of EOS in-orbit payloads and U.S. observatories and facilitate a wide range of scientific research on the Earth System and the interactions of its components. To do so, EOSDIS will support the acquisition, processing, storage, and distribution of the data acquired by these payloads and observatories. In addition, the EOSDIS will have the capability to perform storage and distribution functions for selected non-EOS data sets, Tropical Rainfall Measuring Mission (TRMM) data, Landsat 7 data, and other flight missions as identified in the Functional & Performance Requirements Specification for the ECS (ECS Specification).^{CN02}

This Statement of Work (SOW) is for the development and initial operation of the EOSDIS Core System (ECS), the major component of the EOSDIS in support of the EOS spacecraft and instruments and non-EOS data identified within this contract. (The term *EOSDIS* includes items funded by the EOS Program Office at NASA Headquarters. This contract is supported from that funding source and, therefore, is part of the EOSDIS. In this document, the term *ECS* is used to identify products of this contract while the term *EOSDIS* is used to identify the ECS plus items which are outside this contract.)^{CN01}

The ECS is described in detail in the Functional and Performance Requirements Specification. This SOW describes the process by which the ECS shall be implemented and operated and describes the Contractor's responsibilities in achieving this goal. It is the intention of the EOS Program and the role of the ECS to enhance scientific productivity, foster interdisciplinary science, and maximize the scientific productivity for each dollar spent on the disciplines supported by the Earth Science Data and Information System (ESDIS) Project.^{CN02}

SECTION 1 — INTRODUCTION, of this document, provides the background and context for the ECS, describes the overall scope of the contract, gives a high-level functional description of the system, lists applicable and reference documents. SECTION 2 — SYSTEM DEVELOPMENT APPROACH details the approach to be used, including the phasing of the various levels of system functionality and capacity. SECTION 3 — WORK TO BE PERFORMED provides the detailed statement of the work to be performed by the ECS Contractor under this contract. | CN01

1.2 Background

The purpose of the EOS Program is to provide the science user community with data and the supporting information system necessary to develop a comprehensive understanding of the way the Earth functions as a global system. This includes the interactions of the atmosphere, oceans, cryosphere, and biosphere, particularly as they are manifested in the flow of energy through the Earth system, the cycling of water and chemicals throughout the physical and biological systems. This comprehensive global study of physical, chemical, and biological processes in an integrated context has been termed Earth System Science, and is focused on the development of the capability to accurately predict the evolution of the Earth system on time scales of decades to a century. | CN02

The three main components of the EOS Program are: | CN02

- a. An observing system (the EOS Space Measurement System EOSSMS) to acquire essential, global Earth science data on a long-term, sustained basis and in a manner which maximizes the scientific utility of the data and simplifies data analysis; | CN02
- b. An integrated scientific research program (EOSSRP) to investigate processes in the Earth System and improve predictive models. | CN02
- c. A comprehensive data and information system (EOSDIS) to provide the Earth science research community with easy, affordable, and reliable access to the full suite of Earth science data from U.S. and International Partner (IP) spacecraft. | CN02

The EOS spacecraft and instruments are described in the EOS Reference Handbook. | CN01

The ECS constitutes the major part of the ground component's data and information system. The ECS is conceived as a research information system that transcends the traditional mission data system and includes additional capabilities such as handling long-term, time-series data sets.

In support of this purpose, the ECS will produce science products from EOS instrument data, accept supplementary data products for storage and distribution, provide interfaces to instrument and interdisciplinary investigator Science Computing Facilities (SCFs) which develop science data processing software and perform scientific research, provide data archiving and distribution capabilities, and employ a user interface that will facilitate browsing, requesting, and delivering data from archives to investigators. Research users of the ECS will interface with the system to locate, order, and access Earth science data and information. Research users will provide, for addition to the ECS data base, copies of new data sets they develop. Institutional users of the ECS will include NASA Earth Probe or campaign data systems, other Government data systems and archives, university research programs, the International Partners (IPs), and commercial data systems.

The ECS is also responsible for command and control of EOS spacecraft and instruments, for managing the EOSDIS Science Network (ESN), and for managing its system performance. The spacecraft will provide command interfaces with the instruments, accommodate data flows among instruments, spacecraft subsystems, and data storage devices, and transmit data to the ground.

NASA is developing Version 0 (V0) of the EOSDIS as described in Sec. 2.5.1.1. V0 will provide an interconnection of existing data systems at the DAACs and will perform prototyping tasks in areas such as distributed IMS development, networking, and standards. Also, certain Earth observation data sets will be added to the existing data systems under V0. The V0 effort will continue for several years. The V0 effort will have the following relationship to the ECS:

- a. The ECS Contractor shall analyze results from V0 for possible inclusion into the ECS design;
- b. The ECS Contractor shall connect to the V0 system to provide a level of interoperability;
- c. Selected data sets from V0 shall be copied into the ECS.

1.3 Scope

The ECS Contractor shall design, develop, implement, test, deliver, operate, document, and maintain the ECS in accordance with this SOW and the ECS Specification. The baseline ECS shall meet the requirements stated in the ECS Specification. When this SOW (including any Applicable Documents) requires an approval by the Government, such approval shall be deemed to be approval by the Contracting Officer (CO) and the Contracting Officer's Technical Representative (COTR).

The work defined by this SOW includes, but is not necessarily limited to:

- a. Design, development, and implementation of the ECS, including hardware, software, documentation, training, and services;
- b. Operation and maintenance of the ECS;
- c. Special studies and support as directed by the CO/COTR.

To achieve these three requirements, the Contractor shall perform a variety of activities, including, but not necessarily limited to, those specified below:

- a. The management of the contract, including the technical, schedule, and cost factors;
- b. The performance of an ongoing analysis of EOS requirements; review of techniques, hardware, or software developed outside this contract which could be applied to the ECS; development of prototypes for user sensitive and high-risk or potential high-payoff items and incorporation of their beneficial results into the ECS; and application of the information gained by these activities to planning the evolution of the ECS;
- c. The inclusion within the system development activity of the benefits of the "Version 0" system which will be developed outside this contract and the inclusion of the benefits of prototyping work also performed outside this contract, which are applicable to the ECS (See Section 2.0, "System Development Approach", for a discussion of system versions and prototyping work.);
- d. The design, procurement, development, fabrication, test, delivery, installation, verification, assurance, and documentation of the hardware and software necessary to implement and test the ECS at its various locations, the specification of communications circuits as Government-furnished equipment (GFE) to be provided by the Earth Science Data and Information System (ESDIS) Project, and the coordination with ECS facility sites in the development of site networking. These items are to be provided in a sequence of phased deliveries throughout the contract performance period as defined in the contract schedule;
- e. The engineering liaison with other organizations involved in development of the complete EOS system;

CN02

- f. The internal integration of ECS;
- g. The establishment of interfaces and the integration of the ECS with external Government and non-Government facilities;
- h. The planning, scheduling, execution, documentation, and demonstration of necessary testing by the ECS Contractor to meet the acceptance requirements of the ECS, including the procurement and/or development of the necessary hardware and software;
- i. The maintenance and operation of the ECS;
- j. The training and certification of maintenance and operations (M&O) and successor M&O personnel and the training of investigator, investigator support, DAAC, Government, algorithm developers, and end users of the items provided under this contract;
- k. The performance of special studies and tasks as directed by the CO/COTR that are related to the development of the EOS ground system and overall EOS mission;
- l. The ingest, archival, and distribution of data products from the TRMM, Landsat 7, and other NASA Earth Probe missions as identified; |CN02
- m. The ingest, archival, and distribution of other selected non-EOS data products.

The ECS shall be sized, built, and operated based on the ingest, processing, archival, distribution, and flight operations support (i.e., planning, scheduling, command, and control) requirements per Table 1.3-1. The design of the ECS, however, shall take into consideration the |CN01 overall EOS Program such that additional requirements can, as necessary, be accommodated through expandability (i.e., with no design/architecture impact) for:

- a. Ingest, science data processing, archival, and distribution of data from additional EOS series instruments and selected instruments on other foreign observatories; |CN01
- b. Ingest, archival, and distribution of data products from additional Earth Probe missions;
- c. Ingest, archival, and distribution of other existing Earth science data products as directed; |CN01
- d. Simultaneous flight operations support for two EOS spacecraft during transition.

The design of the ECS shall also accommodate with minimal design/architecture impact:

- a. Instrument control center functions for selected instruments on foreign observatories; |CN01
- b. Full flight operations support for other observatories and instruments as approved. |CN01

The ECS contractor shall design the ECS to accommodate missions per Table 1.3-1.

Per Table 1.3-1, the contractor performs flight operations system engineering for future missions. Specifically the contractor shall perform the following activities for these future missions: | CN09

a. The management of the overall analysis, planning, scheduling and control for future missions. | CN09

b. Early requirements analysis for each potential future mission. | CN09

c. FOS management and supporting infrastructure for specified future missions. | CN09

d. Continuous evaluation of technologies applicable to flight operations, including identification, installation, and evaluation of these technologies. Conduct advance preparation for potential procurement of selected technologies. | CN09

e. Computer system hardware engineering for future missions. | CN09

f. Early system engineering for future missions. | CN09

g. Implementation of hardware, software, and maintenance required for multiple spacecraft operations, analysis, data management, planning and scheduling, and communications interfaces. | CN09

The ECS shall be implemented nominally at nine geographic locations as defined in Section 1.4. The Contractor's design shall accommodate changes in the number and location of the sites with no design/architecture impact. | CN02/
CN06

ECS Design And Implementation Requirement

MISSION	PRODUCT GENERATION	ARCHIVE	DISTRIBUTION	FLIGHT OPERATIONS	
TRMM	I*	I	I	N/A	
LANDSAT 7	N/A	I	I	N/A	
EOS AM	I	I	I	I	CN01
COLOR	I	I	I	N/A	
AERO	I	I	I	SE	CN09
EOS PM	I	I	I	SE	CN09
ALT	I	I	I	SE	CN09
CHEM	I	I	I	SE	CN09

I - Design and Implement
 * - CERES & LIS instruments only
 SE - Perform system engineering for future implementation

Table 1.3-1

This ECS SOW describes the performance requirements with which the ECS shall comply during the period of performance of the contract. It also describes certain requirements for expandability or future expansion beyond those performance requirements with which the ECS must comply during the period of performance of the contract. These requirements for expandability or future expansion may be added to the ECS during the period of performance of the contract; therefore, the design implementation and maintenance and operations of the ECS must contain the hooks necessary to permit such expansion. Unless explicitly limited to expandability or future expansion, the terms “shall”, “shall provide the capability”, “shall have the capability”, and “shall be capable” shall be interpreted identically and mean that the function, service, capacity, etc. described is a mandatory and current requirement for the baseline ECS with which the Contractor must comply during the period of performance of the contract.

This SOW lists the reviews and documents of primary importance to the CO/COTR. This SOW does not specify all of the documents, reviews, system releases, or activities that the Contractor will have to accomplish to meet the objectives of the contract over the entire period of performance. The Contractor shall define the additional documents and reviews which are appropriate and document them in the System Implementation Plan in accordance with Data Item Description (DID) 301/DV1 of the ECS Contract Data Requirements Document (CDRD). The CDRD Introduction provides definitions of the DID number.

1.4 ECS Functional Description

For the purposes of this procurement, a conceptual architecture for the operational ECS is provided. The overall ECS is conceived as a hierarchy of segments, elements, and subsystems. Three ECS segments are defined to support three major operational areas: flight operations, science data processing, and communications and system management. The segments are further divided into ECS functional elements. Subsystems refer to the hardware and software systems and equipment supporting the ECS elements. This architecture is illustrated in Figure 1.4.1-1. Unless expressly excluded by the contract, these ECS segments, elements, subsystems, and components shall be provided by the ECS Contractor.

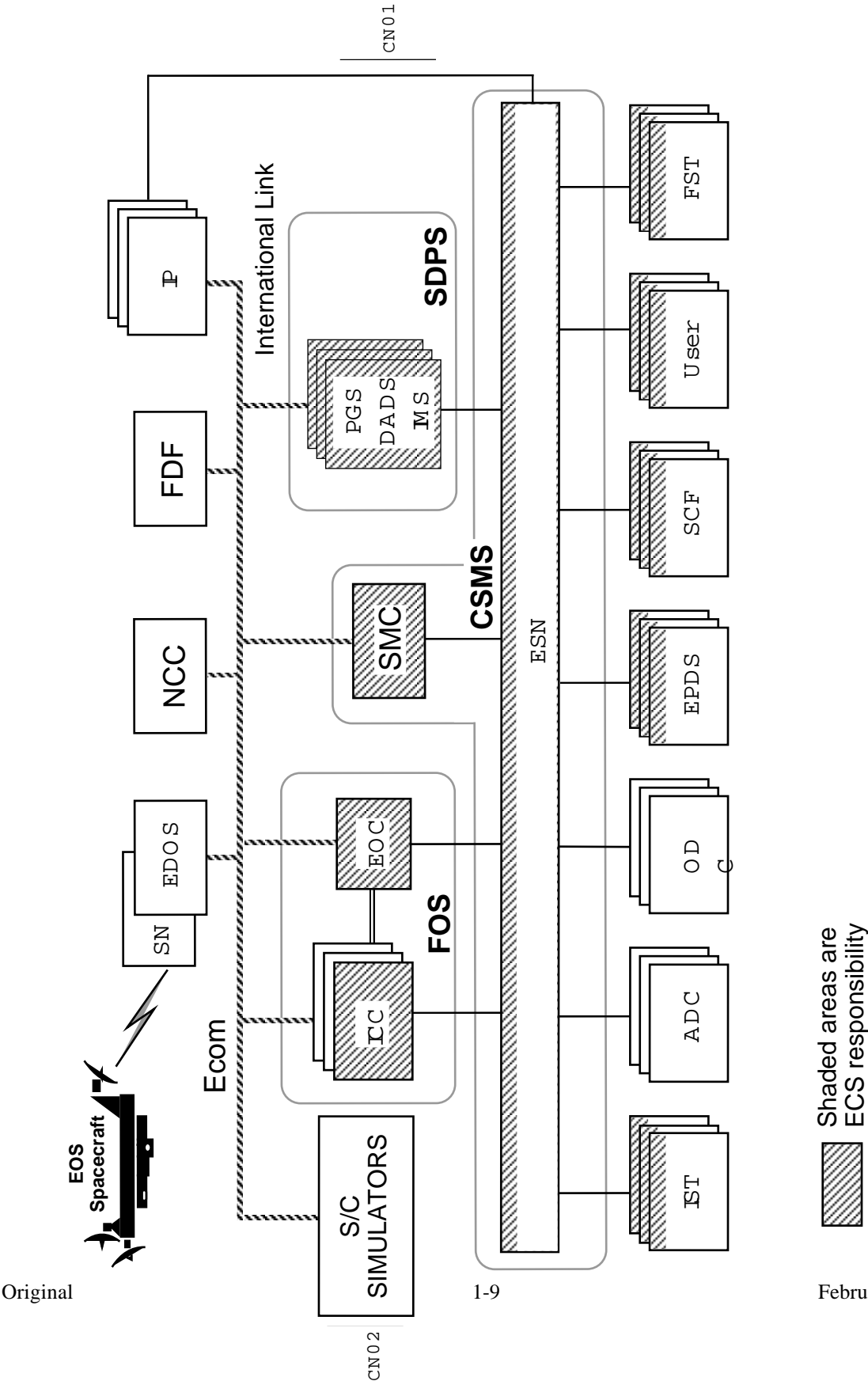


Figure 1.4.1-1 ECS Logical System Architecture

1.4.1 ECS Functional Elements

The three ECS segments and their functional elements are:

- a. A Flight Operations Segment (FOS) which manages and controls the EOS spacecraft and instruments. The FOS elements include:
 - 1) EOS Operations Center (EOC) — The Goddard Space Flight Center (GSFC) element responsible for mission planning and scheduling and for the control and monitoring of mission operations for the spacecraft and instruments. | CN01
 - 2) Instrument Control Centers (ICCs)/Instrument Control Facilities (ICFs) — The ICCs are the elements responsible for scheduling, commanding, and operating the science instruments and for monitoring instrument performance. Several ICCs constitute an ICF. The FOS also interfaces to ICCs at International Partner Facilities. | CN02
 - 3) Instrument Support Terminals (ISTs) — Investigator-site ECS software toolkits to connect a Principal Investigator (PI) or Team Leader (TL) to an ICC in support of remote instrument planning and monitoring. (Investigator facilities are shown outside the FOS in Figure 1.4.1-1; they are connected to the FOS via the EOSDIS Science Network (ESN).) IST toolkits are hosted on user-provided systems. | CN01
- b. A Science Data Processing Segment (SDPS) which provides a set of processing, archival, and distribution elements for science data and a data information system for the entire ECS. The SDPS elements include:
 - 1) Distributed Active Archive Centers (DAACs) — Each institutional DAAC facility will consist of a Product Generation System (PGS), a Data Archive and Distribution System (DADS), and a portion of the Information Management System (IMS). The ECS hardware and software will process data from the EOS instruments to standard, Level 1-4 data products, provide short- and long-term storage for EOS and selected non-EOS data, and distribute the data to EOS users.

ECS DAACs will be located, at a minimum, at the following institutions:

- (a) Goddard Space Flight Center (GSFC)
- (b) Marshall Space Flight Center (MSFC)
- (c) University of Alaska — Fairbanks (UAF) Facility
- (d) U.S. Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
- (e) Jet Propulsion Laboratory (JPL)
- (f) University of Colorado — National Snow and Ice Data Center (NSIDC)
- (g) Langley Research Center (LaRC)
- (h) Oak Ridge National Laboratory (ORNL) | CN01
- (i) Consortium for International Earth Science Information Network (CIESIN) Socio Economic Data and Applications Center (SEDAC) | CN06

- 2) Information Management System (IMS) — a distributed information management system for the ECS that includes a catalog system to support user data selection and ordering. The IMS will be implemented in a distributed configuration, with the distribution of IMS functions between the DAACs and an IMS coordinating element to be optimized to meet the requirements of the ECS Specification. The IMS must function as a single integrated service from the point of view of the user, and must present the same comprehensive view of the ECS from any IMS access node. The distribution of IMS functions must not compromise the integrity of the IMS as a whole.
- c. A Communications and System Management Segment (CSMS) which provides overall ECS management and operations of the ground system resources, facilities, and communications/networking services for an extensive science data communications network and interfaces to NASA's Space Network (SN), EOS Communications (Ecom), ^{CN02} Program Support Communications Network (PSCN), and other communication networks. The CSMS elements include:
 - 1) System Management Center (SMC) — a system management service for ECS ground system resources.
 - 2) EOSDIS Science Network (ESN) — a dedicated internal ECS communications network for providing interconnection services for the widely distributed ECS facilities, IPs, and EOS investigators at their ISTs or SCFs as required to support ECS operations, and a separate network interface from the ECS to gateways provided by the NASA Science Internet to external science research networks in support of other science communities' access to the ECS.

There are other EOSDIS components that are themselves outside the scope of the ECS contract and which will be separately provided by the Government. These are shown as unshaded boxes or portions of boxes in Figure 1.4.1-1. Shaded areas in the IST, SCF, Users, and FST boxes in Figure 1.4.1-1 represent ECS software toolkits that will reside on compatible external hardware.

The SCFs at the investigator sites are designed to support algorithm development, product quality assurance, and research activities. The interface and algorithm toolkits necessary to support these activities will be provided by the ECS Contractor.

FSTs are portable, user-provided terminals or workstations which can be employed at field investigation sites. The FST will provide access to the IMS, allowing a field investigation team to browse the EOSDIS catalog system for data of immediate interest, and to request data which could be delivered to the field location for use by the field team. (FSTs are shown outside the

SDPS in Figure 1.4.1-1; they are connected to the SDPS via the ESN.) ECS software toolkits are hosted on the FSTs.

The ECS will have significant interfaces with other EOS-unique components, including the EOS spacecraft and the parts of the DAACs that will be implemented outside this contract. The ECS Contractor shall provide required interface standards, definitions, documentation, and technical assistance necessary for interfacing these components to the ECS. |CN01

The Earth Observing System (EOS) Data and Operations System (EDOS), a data handling and data distribution capability being developed by GSFC, will process EOS data to Level 0, provide production, quicklook, and real-time data to the ECS, maintain a backup archive of Level 0 data, and provide copies of this backup data (previously transmitted) upon request of an ECS DAAC. |CN02

In addition to EDOS, other NASA institutional elements will play a role in supporting ECS. These institutional elements include: Space Network (comprised of the Tracking and Data Relay Satellite System (TDRSS), the two TDRSS ground terminals, and the Network Control Center (NCC)), the Ground Network (GN), the Deep Space Network (DSN), Ecom, the PSCN, NASA Science Internet (NSI), and Flight Dynamics Facility (FDF). |CN02

1.4.2 ECS Operations Concept

Basic ECS operations are discussed in this section in terms of the three operational segments.

1.4.2.1 FOS Operations

The EOC provides the capability for mission management and coordination. This function includes overall spacecraft and instrument responsibility (including command and control of the spacecraft, planning, scheduling, and health and safety monitoring) and coordination with the ICCs, the IPs, and other non-ECS institutional elements such as the FDF or the NCC. |CN02

The ICFs at GSFC will support the ECS. In addition, there will be ICCs in Japan and Europe. An ICF consists of one or more ICCs, each responsible for monitoring the health and safety of its instrument, generating commands, and coordinating plans and schedules with the EOC. The ICCs will interface primarily to the EOC for spacecraft operations. The IPs will also provide ICCs in their countries to operate their instruments on the U.S. spacecraft. |CN01 |CN02

The ECS Contractor shall provide software (toolkits) for ISTs. ISTs will allow a remote instrument scientist to participate in the planning and scheduling function, review engineering data, develop command requests, and assist in the resolution of anomalies.

1.4.2.2 SDPS Operations

Production of scientifically useful Level 1 and higher data products from the EOS instruments is distributed across the DAACs. The DAACs then store the generated products in a manner which provides convenient access to the data for distribution in support of the users. The DAACs will be designed to support long-term archiving of standard and other pertinent products.

The DAACs will receive Level 0 data from EDOS and will generate standard products, metadata, and standard browse products for these standard products. Standard Level 1 through Level 4 products will be produced routinely using approved algorithms. Standard browse products also will be produced routinely for the standard products, providing investigators a quick way of examining the potential suitability of a standard product without actually having to order it. In addition, DAACs will produce certain standard and prototype products, for limited geographic areas and time periods, in response to approved requests.

For the instruments, the investigators are responsible for the development and maintenance of the algorithms (science data processing software) for the production of the products. They are also responsible for reviewing the products produced and for providing quality control/validation of the results. Computing facilities at the SCFs provide for the development and testing of algorithms, data calibration and validation, the assessment of data quality, and support of investigator research.

Interdisciplinary Investigators (IIs) will use SCFs in their research. They will obtain various levels of data from the DAACs and will produce additional products for archival and distribution under ECS. Some IIs will undertake standard product generation through the PGSs with responsibilities identical to those for instrument PIs as described above.

Due to the large volume and complexity of the EOS data collection, the ECS will provide the science user community with the capability to effectively locate and order the data required to support research. Information about all aspects of the ECS data will be available from the IMS which provides a single point of contact from which all ECS data can be requested. The IMS will transmit the request to the appropriate DAAC, monitor the response, and provide accounting

information. The IMS will provide production status information and information about data and data products.

The IMS will provide user information on ECS data, processing status, science processing software, available data products, and mission descriptions and schedules. It will provide user information searches of ECS metadata and access to other ECS elements and external science data systems from users' home facilities. The IMS will help users form requests for data products, route and track requests, and provide user access to status and accounting information. It will also help form user requests for future data acquisitions and non-routine data processing, will decompose, sequence, and route those requests to the appropriate ECS element, and will provide other electronic library services as necessary.

1.4.2.3 CSMS Operations

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The SMC will provide system-wide coordination and tracking of ECS operations and resources. The SMC will ensure that production schedules involving inter-DAAC product dependencies are met. The SMC will provide a source for administrative, security, and accounting management on a system-wide basis, with corresponding administrative, security, and accounting functions at the individual element level.

The ESN will include a high capacity, dedicated communications network, internal to the ECS, that supports ECS operations (e.g., operational transfer of data and products between DAACs required for standard product generation, between a DAAC and an SCF to support operational product Quality Assurance (QA) and validation, or to IST/ICC instrument operations support. The ESN will also provide an interface to the NASA Science Internet (NSI) to connect with users for access to the IMS to locate and order data sets or request other information and also to provide the path for electronic delivery of requested data to the user. The internal operational network will be isolated from the gateway connections for general user access.

1.5 RESERVED

1.6 Relation to Other Activities

There are several activities related to the ECS which will be conducted both before and during the performance period of this contract. Existing facilities will be augmented and interconnected

to form a predecessor to the ECS. This arrangement, called the "Version 0 System", is expected to provide early experience with a system like the ECS and should provide a valuable source of information which the Contractor is expected to review and include in the ECS. In addition to the Version 0 System, the EDOS development contract, the EOS Communications (Ecom), the spacecraft contract, the instrument development contracts, EOS Investigator contracts and grants, and the Independent Verification and Validation (IV&V) of the ECS.

1.6.1 RESERVED

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1.6.2 EDOS

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The EDOS is being developed by the EOS Program as a forward and return link data handling and distribution capability for utilization during the EOS era. EDOS shall perform Level 0 data processing on EOS data, provide level 0 back-up archive, and prepare command loads for uplink to EOS. The development of EDOS will occur in parallel with the ECS development. Integration testing with ECS and EDOS elements operating concurrently will be necessary to accomplish functional and interface testing for both systems. EDOS will be developed on a schedule similar to the ECS with NASA coordinating the schedules of both contracts as required to facilitate testing. The ECS IV&V contractor will be responsible for conducting ECS/EDOS verification activities with support from the ECS Contractor as required. As a minimum, test support provided by the EDOS contractor shall include coordinating activity schedules with the IV&V contractor and providing the necessary support and operations personnel required for conducting the test activities. The ECS Contractor shall exchange technical interface information with the EDOS contractor and support the preparation of the ICD between the ECS and EDOS.

| CN02

1.6.3 Ecom

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The Ecom will also be developed during the ECS development period. The Ecom will provide for the operational data communications between the EDOS and the ECS for both forward and return link data. Ecom will provide data transport at the required rates and volumes consistent with EOS Program needs utilizing standard communication protocols. Ecom will provide data

transport for forward link data from the EOC to the EDOS at White Sands for relay to the EOS spacecraft and instruments via the Space Network. On the return link, Ecom will provide communication services for the transmission of EOS science and engineering data from EDOS to the ECS locations. Ecom will be developed on a schedule similar to the ECS and EDOS schedules with NASA coordinating the schedules of the contracts as required to facilitate testing. Test support by the ECS Contractor shall be as stated for EDOS in Section 1.6.2. The ECS Contractor shall exchange technical interface information with the Ecom contractor and support the preparation of the ICD between the ECS and the Ecom. CN02

1.6.4 IV&V of the Ground System

The ESDIS Project will award a separate IV&V contract that will verify EOS Ground System integration testing (i.e., integration of EOS flight system and non-ECS elements of the ground system with ECS elements) and perform final operational integration certification testing for each external ECS interface. In addition, the IV&V contractor will validate the ECS elements with respect to the ECS Level 3 (i.e., ECS Specification) requirements and verify that ECS elements operate correctly within the EOS Ground System (revalidate EOS Ground System Level 2 requirements). Furthermore, the IV&V contractor will track and support the resolution of discrepancies identified during EOS external IV&V testing. The ECS Contractor shall be required to exchange technical and planning information and cooperate with the IV&V contractor. CN02

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1.6.5 EOS Spacecraft Contracts

The EOS spacecraft contracts will provide the U.S. orbiting EOS spacecraft, the spacecraft simulator, and essential information concerning operation of the spacecraft which will be required for implementation in the EOC. In addition, the EOS spacecraft contracts will provide operations personnel in the EOC for pre-launch and for the initial period of on-orbit operations. The spacecraft contractors will provide spacecraft analysis tools to the ECS Contractor for implementation and for integration into the EOC. The ECS Contractor shall exchange technical information with the EOS spacecraft contractors and develop operations personnel phase-over plans for assuming operational responsibilities when the EOS spacecraft contractor personnel phase out of the EOC. CN02

The ECS Contractor shall be responsible for the software to convert selected spacecraft engineering and housekeeping data into the ancillary data products necessary for generation of Level 1 standard products and to perform limit checking of these data parameters. In providing this software, the ECS Contractor shall coordinate with the EOS spacecraft contractors or other designated sources to obtain configuration controlled calibration data and calibration methodologies. |CN02

1.6.6 Instrument Development Contracts

|CN02

Individual contracts will be written by the Government for development, test, and integration of the instruments. The ECS Contractor shall exchange information with the instrument contractors. The EOC and ICCs shall provide test support during spacecraft and instrument integration testing as part of comprehensive system tests before the EOS launches. |CN01

1.6.7 EOS Investigator Contracts

Contracts will be established with (or grants made to) of the scientists involved in EOS, including the facility instrument Team Leaders (TLs) and Team Members (TMs), the individual instrument PIs and Co-Investigators (Co-I's), and the IIs. These contracts or grants will include development of coded science algorithms which the ECS Contractor shall support integrating into the ECS. The ECS Contractor shall exchange technical information with these scientists, and incorporate coded science algorithms into the ECS. The scientists will perform integration testing at the DAACs and will maintain the coded science algorithms throughout the EOS mission.

1.6.8 Foreign Instrument Contracts

As the name implies, foreign instruments will be developed outside of the U.S.; however, some of these instruments will fly on the U.S. spacecraft (e.g., ASTER, MIMR). The ECS Contractor will be expected to exchange information with those organizations that will provide instruments to be flown on the U.S. spacecraft. The nature of the contractor-to-contractor interfaces and the support to be provided by the ECS Contractor will be similar to that provided for the U.S. instruments. |CN02

1.6.9 DAAC

The Contractor is to install, operate, and maintain the hardware and software at the DAACs necessary for data ingest, product generation, archival, and distribution. DAAC personnel may augment the DAACs outside the scope of this contract. Additionally, each DAAC Project Manager may request the ECS Contractor perform special studies and support by forwarding task requests to the ESDIS Project for approval. The CO/COTR may negotiate transitions of M&O responsibility from the ECS Contractor to the DAAC sites as agreements are established with the DAAC sites. |CN02

The contractor is not required to install, operate, and maintain hardware and software at the CIESIN SEDAC. The government will provide ECS developed software and documentation to the CIESIN SEDAC. The contractor shall provide technical consulting services to CIESIN SEDAC in support of ECS software integration into the CIESIN SEDAC hardware environment. |CN06

1.6.10 DELETED

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1.7 Government Furnished Facilities, Equipment, and Services

The EOSDIS Facility (see Appendix B) will be provided at GSFC to house the EOC, GSFC ICF, GSFC DAAC, SMC, GSFC ESN components, EOSDIS library, supporting development, and EOS ground system and operations management functions. This facility will provide space for a permanent installation of the GSFC ECS equipment with maintenance and operations (M&O), workstation, and storage spaces. The beneficial occupancy date (BOD) for this building is given in the GFE clause of the contract.

Before the BOD, development and M&O support shall be performed at Contractor-supplied facilities. For initial planning purposes, layout of the Government-furnished building at GSFC and available space are shown in Appendix B, Electrical and Mechanical Requirements & Preliminary Floor Plan for EOSDIS Facility.

Availability dates of DAACs and other facilities not located at GSFC have not been identified, but the ECS Contractor shall assume they are consistent with the Delivery Schedule defined in this contract. The ECS Contractor shall develop and provide facility requirements for each of the

DAAC sites. Existing capabilities and facilities at these sites shall be considered in their facility planning.

ECS-developed toolkits will be hosted on user-provided systems, e.g., workstations, FSTs, and SCFs. These user-provided systems shall meet the requirements and standards specified by the Project. The Contractor shall support the definition of these requirements and standards and shall provide toolkits that depend only on the standards. Installation/integration of toolkits is the responsibility of the user; however, the ECS will provide assistance to the users via help services.

The Government will furnish the communications circuits for the ESN backbone and tail circuits. Remaining EOSDIS value-added networking/communications requirements, such as network hardware and software, network management, DAAC LAN support, and other services including user directory and information systems, shall be provided by the ECS Contractor. The Contractor shall prepare, based on the User Requirements Study, circuit requirements for PSCN|CN04 and level-of-service requirements for NSI in keeping with schedules for ordering and implementing the circuits in accordance with DID 220/SE1.

1.8 Applicable and Reference Documents

1.8.1 Applicable Documents

Applicable Documents (ADs) are those specifications, standards, criteria, etc. used to define the requirements of this SOW. In the event of a conflict between an AD and the SOW, the SOW takes precedence. Should a conflict occur among ADs, the Contractor shall request resolution from the Contracting Officer (CO). ADs shall be considered firm requirements and are binding on the Contractor as defined below:

- a. First tier ADs are those directly cited in the SOW and are listed in this section. These documents, of the exact issue shown, form a part of this SOW to the extent specified herein; where no issue is shown, the revision in effect as of the date of this contract shall be used.
- b. Second tier ADs are those directly cited in the first tier AD. These documents are ADs to the extent specified in the first tier documents.
- c. Third tier ADs are those directly cited in second tier ADs. These and lower tier documents are for guidance only.

The following documents are applicable to this SOW (1st tier).

2/16/93	Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System NOTE: This document is typically identified throughout this SOW as the "ECS Specification."
420-05-03; 5/23/91	ECS Performance Assurance Requirements for the EOS Data and Information System (EOSDIS) Core System (ECS)
420-02-02; 1/90	Earth Observing System Configuration Management Plan
2/16/93	Contract Data Requirements Document
NASA-STD-2100-91; 7/29/91	NASA Software Documentation Standard, Software Engineering Program

1.8.2 Reference Documents

Reference Documents are those documents included for information purposes. The Contractor is bound by these documents to the extent specified in first or second tier ADs or in this SOW.

The following documents are reference documents to this SOW.

Science References:

National Aeronautics and Space Administration, Earth Observing System Reference Handbook, NASA Goddard Space Flight Center, Greenbelt, Maryland, May 1991

Dutton, J. A., The EOS Data and Information System: Concepts for Design, IEEE Transactions of Geoscience and Remote Sensing, 27, 109-116, 1990

National Aeronautics and Space Administration, Early-EOSDIS Program Plan, NASA Headquarters, Washington, D.C., 1990

Science Advisory Panel for the EOS Data and Information System (EOSDIS), Initial Scientific Assessment of the EOS Data and Information System (EOSDIS), EOS-89-1, 43 pp., NASA Goddard Space Flight Center, Greenbelt, MD, 1989

Dozier, J., Looking Ahead to EOS: The Earth Observing System, Computers in Physics, May/June 1990

Engineering References:

STDN-402	System Maintenance Program
11/9/90	EOSDIS Version 0 Implementation Plan
500-TIP-2110; 3/91	Specification for Document Formats
500-TIP-2111; 4/90 (draft)	Specification for Content of Operation and Maintenance (O&M) Manuals
GHB 5112.1; 8/88	Performance Measurement System Handbook
GHB 7120.1; 8/71	GSFC Handbook for Preparation and Implementation of Work Breakdown Structures
500-TIP-2201; 3/91	Style Guidelines for MO&DSD
500-TIP-2601; 3/27/91	Standard for Automated Interchange of MO&DSD Technical Information
500-TIP-3109; 5/90 (draft)	Standard for Product Data
535-TIP-CPT-001; 10/90	Contractor Provided Training Specification
X-673-64-1D; 1/85	GSFC Engineering Standards Design Manual
MIL-M-28001A; 12/88	Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text
MIL-STD-1840A; 12/88	Automated Interchange of Technical Information
NHB-4200.1C; 6/25/87	NASA Equipment Management Handbook
MIL-STD-1388-1A; 10/73	Logistics Support Analysis
MIL-STD-1388-2A; 7/84	Logistics Support Analysis Record
4/19/91	ECS Integrated Logistics Support Plan
NMI 8610.22; 12/5/89	National Resource Protection Program
7/91 (draft)	EOS Support Instrumentation Requirements Document (SIRD)
NHB 9501.2B	Procedures for Contractor Reporting of Correlated Cost and Performance Data

PROGRAM REFERENCES:		CN01
None	EOS Reference Handbook, March 1993	CN01
None	ESDIS Project Level 2 Requirements (Volumes 0-5)	CN01

SECTION 2 — SYSTEM DEVELOPMENT APPROACH

2.1 Evolutionary Approach

This section describes the evolutionary approach the Contractor shall follow in development and implementation of the ECS. The EOSDIS, including the ECS, shall be designed and implemented so as to effectively adapt to change on an ongoing basis, and still achieve the stability required of a system that must support operational product generation and manage large volumes of EOS instrument data over the project lifetime.

The evolutionary approach includes phased implementation with continual, active, iterative participation by users, prototyping, special studies, and the use of standards and approaches to hardware and software that facilitate evolution of ECS. The evolutionary approach is planned to embody a cyclical process of reviewing the ECS requirements and design. Revisions shall be incorporated into the ECS that explicitly address the results of user feedback and prototyping work. Contractor actions required to implement this approach are addressed in this section, and repeated in subsections in Section 3.0 of this SOW.

2.1.1 Design Strategies and Goals for Evolution

The Contractor shall develop a design strategy to create a system that can gracefully grow and evolve, is flexible, and has reduced risk, complexity, and cost. Strategies to accomplish these goals shall include current and evolving open systems, creating modular components to isolate change impacts, and analyzing the system for functional commonality across elements. Specific strategies shall include a layered reference model and system-wide design disciplines.

2.1.2 Architecture Change Analysis

The Contractor shall conduct Architecture Change Analyses to estimate the evolvability of the ECS architecture to future user paradigm changes and major advances in information system technology. The architecture change analysis complements System Design activities (see section 3.2.3.1). System design focuses on developing the system to meet the present baseline of requirements, whereas architecture change analysis looks towards the future evolvability of the system architecture.

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A system architecture change analysis shall consist of the following activities: | CN07

1) Identify the system architecture presently planned for the final release of this development contract. | CN07

2) Identify the evolvability test to be used in this architecture change analysis | CN07

3) Identify impact to the system and develop transition plans for the evolvability test | CN07

4) Recommend architecture modifications to minimize potential costs of transition. | CN07

Architecture change analyses are to be conducted for SDR and PDR/IDRs as directed by the ESDIS project office. Evolvability tests will be identified at the time of initiating the analysis. Evolvability tests describe areas of potential change that may affect the system in its extended lifetime. Examples of evolvability tests are as follows: | CN07

- Multi-media collaborative environments: including videoconferencing, alternate media (audio, full motion video, animation) in documents, standardized electronic document formats | CN07

- Low-end bandwidth mutual access to ECS by new service providers | CN07

- Heterogeneous (e.g. non-Posix compliant) operating system environment | CN07

- Dynamically adding or dropping a DAAC, SCF, ADC or ODC | CN07

- Advances in extended relational and OO Databases | CN07

- High Performance Computing (MPP proliferation and workstation farms) | CN07

- Networked in situ sensors: deployed sensor arrays with real time data acquisitions | CN07

- Active load balancing across available ECS resources, e.g. DAACs and other service providers, e.g. SCFs, ADCs, ODCs, etc. | CN07

2.1.3 Incremental Development

The Contractor may develop certain portions of the ECS using an Incremental Development process. Incremental Development is characterized by a short development cycle (e.g. 6 to 9 months) that results in multiple deliveries of functionality within a single release. Software developed using this process shall be integrated into deliveries called Evaluation Packages in order to rapidly obtain user feedback. The Incremental Development process shall be conducted in parallel with the formal development of the remaining areas of ECS. The two development paths shall converge prior to Segment Integration and Test with each development track conducting TRRs. CN07

Incremental Development may be used for those areas of the system where requirements are less well understood and iteration of requirements and design is anticipated with user evaluation. Formal Development shall be used where requirements are more mature and stable. Incremental development may also be used in COTS intensive parts of the system and to develop system infrastructure in support of other incremental developments CN07

In order to enable rapid incorporation of user feedback, the Incremental Development process shall incorporate steamlined review and documentation requirements. Once the user evaluation process is complete software documentation shall be upgraded, if necessary, and integrated into appropriate contract deliverables. Software developed using Incremental Development shall conform to Formal Development coding standards. CN07

2.2 Prototyping and Special Studies

In support of the system development activity covered by this SOW, the ECS Contractor shall perform prototyping to support the definition of specifications and design in the system development process. In addition, prototyping shall support the resolution of high risk or questionable areas and provide early validation of the design of user sensitive areas. The purpose of the prototyping shall be to test and evaluate alternative concepts, approaches, or implementations (which involve newly developed technology) of ECS functions.

The Government will manage an overall prototyping program performed in support of the development of the EOSDIS. This program will involve work performed by the ECS Contractor and others with the results of the prototyping work applied to the ECS. During the life of the

contract, the CO/COTR will identify additional prototyping efforts to be performed by the Contractor or evaluated in the ECS development effort.

Contractor prototyping activities shall include on-going participation and evaluation by representative science users identified by the ESDIS Project with the advice of the Science|CN02 Advisory Panel for EOSDIS. Contractor prototyping test and evaluation shall be performed off-line to the ECS. Solutions approved by the ESDIS Project and Science Advisory Panel shall be|CN02 incorporated into the ECS in an orderly manner without disrupting the existing ECS performance baseline. If a prototyping activity requires connection to the operational ECS to perform full-scale testing, the connection shall be accomplished in a controlled manner with minimum disruption to ongoing operations.

In addition to prototyping, the ECS Contractor shall conduct special studies and trade-off studies involving analyses of specific areas of concern identified or approved by the CO/COTR. These study efforts will be related to prototyping activity and will also be performed for topics of concern without actual prototyping. As with prototyping work, study efforts performed by the ECS Contractor will be managed by the CO/COTR from a perspective of the EOSDIS. Studies that shall be conducted in direct support of system development include, but are not limited to, those listed in [Table 2.2-1](#), Trade-off Studies. The CO/COTR shall be informed prior to the start of these studies to ensure coordination with NASA and other study activities. Modifications or additions to the initial study list shall be approved by the CO/COTR.

The Contractor shall perform a study to analyze and characterize the I/O and on-line buffer storage requirements of the PGS and DADS. This study shall include driving requirements and impacts of contingencies, scheduling problems, and peak loads. This study shall include scenarios of normal and abnormal operations, including delayed receipt (hours to days) of input data (Level 0, ancillary, in-situ, etc.) required to generate standard products.

Study Identification	Area	Rationale	Need Date	
Processing versus Storage	SDPS	Determine which products are better suited for processing on demand as opposed to archival storage to save archive cost	Release A CDR	CN05
Browse/Compression concepts	SDPS	Work with scientist to develop a toolset of browse algorithms and how they should be used (e.g. "this algorithm works well for identifying cloud-free areas at 20:1 compression"). Browsing data before ordering can help scientist work faster and minimize amount of data ordered.	Ongoing	
Earth science oriented conceptual data structures	SDPS	Determine most natural way to organize ECS data from earth science point of view to minimize response times and reduce tape handling. Consider additional techniques to improve response time (e.g. data duplication)	Release A CDR	CN05
Opportunities for parallel computing	SDPS	Evaluate the minimum cost per MIP hardware (e.g. MIMD machines) and parallelizing software for use by science algorithms. Evaluate algorithm rehosting impacts. Track work being done by the community in this area.	Release C CDR	CN05
Artificial intelligence technology	FOS SDPS CSMS	Evaluate further use of AI technology to reduce operations cost and improve science utility, including analysis and prototyping of various AI techniques (e.g. neural networks)	Release B CDR	CN05
Link to regional weather forecasting	FOS	Determine techniques/tools for 3 to 4 orbits advance scheduling of instrument and science experiments to improve opportunities for effective data collection	Release B CDR	CN05
Geographically distributed model execution	SDPS	Analyze how ECS can support distributed model execution	Year 2000	
ECS services expansion	SDPS	Analyze where new ECS services can exploit emerging technology such as NREN	Year 2000	
Users profile evolution	SDPS CSMS	Analyze how ECS design response changes as EOS moves from investigator-based, driven by instrument data processing, to interdisciplinary based, driven by requests for higher level and special products. Also, study effects of increasing numbers of nonscience users.	Release A CDR	CN05
COTS characterization	CSMS	CSMS is very COTS intensive; it depends on both new and evolving standards	Release A-B CDRs	CN05

Table 2.2-1 Trade-off Studies

| CN07

2.2.1 Evaluation Packages

Evaluation Packages are a delivery mechanism for early deployment of Incremental Developments and selected Prototypes. The purpose of the Evaluation Packages is to solicit user evaluation early in the development cycle. Starting no later than 3 months after award of contract, the Contractor shall develop, operate, and maintain an Evaluation Package. Evaluation packages containing early versions of ECS functionality and useful science data shall be installed and operated in the Evaluation Package for use and evaluation by the science community. An Evaluation Package Readiness Review shall be held prior to deployment of an Evaluation Package for user evaluation.

| CN07

2.3 Standards and General Approaches for Hardware and Software

ECS hardware and software shall be implemented in a manner that facilitates evolutionary change by incorporating the ability to adapt to changing requirements. In addition, the ECS Contractor shall perform ongoing studies and trade-off studies to compare the system to the outside world of science and technology advances, and shall monitor user satisfaction and system performance. The general approaches for hardware and software described in this section apply to all elements of the ECS.

The Contractor shall establish a vendor independent, experienced COTS hardware and software procurement organization to ensure that COTS products integrate effectively into the ECS with the most appropriate technology at the best price. This organization shall test and evaluate new and emerging technologies, and work to influence vendors to produce COTS products consistent with the needs of ECS. This organization shall seek access to long-term and near-term technology and product developments from equipment and software vendors. The

COTS procurement organization shall work closely with the segment/element development organization to understand the requirements and exchange knowledge of technology projections.

2.3.1 Standards

A partial list of adopted standards will be provided by the CO/COTR at the time of Contract Award and others will be added as they are adopted. Many of the provided standards will be adopted in the course of the Government's independent work with the EOSDIS Version 0 and interaction with evolving standards. The Contractor shall actively pursue the definition of standards and shall propose additional standards for CO/COTR review and approval. The Contractor shall propose standards to be followed in the ECS design, drawing on the Contractor's knowledge of applicable industry standards, of evolving standards, and of standards that are accepted by the Earth science community. After agreement between the CO/COTR and the Contractor concerning the standards to be adopted, the CO/COTR will notify the Contractor in writing to apply them to the ECS design and development activity. Standards to be adopted for the ECS will cover such items as:

- a. Communications;
- b. Data exchange;
- c. Metadata and browse data formats;
- d. User interfaces;
- e. Computer languages — e.g., Ada, C, Fortran;
- f. Programming conventions which affect the development of science data processing algorithms and that assure Posix-compliant software;
- g. Operating systems — e.g., UNIX and Posix-compliant;
- h. Storage.

The ECS shall be designed to allow incorporation of new standards in operating systems, data formats, software, and metadata formats in a way that minimizes adverse impact to the current users of the system.

Standards to be adopted for the ECS shall meet the following precedence order:

- a. International;
- b. National;
- c. Commercial;

- d. Agency;
- e. ECS.

Where the Contractor's internal standards are deemed appropriate for the ECS, the Contractor shall propose their use to the CO/COTR. The CO/COTR will then review and approve or reject the proposed standards. The Contractor shall comply with the Federal ADP and Telecommunications Standards Index as applicable.

2.3.2 Hardware and Software Approaches

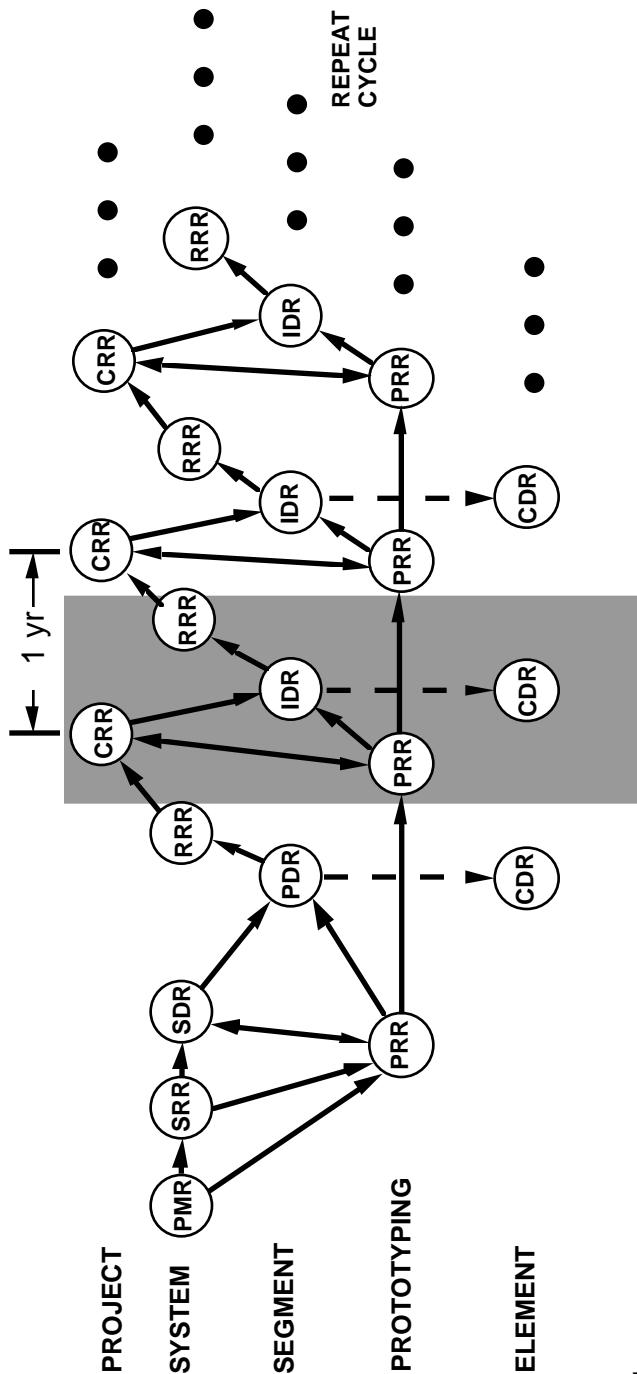
The Contractor shall use commercial off-the-shelf (COTS) hardware unless it can be demonstrated that cost, risk, and technical factors support a custom solution. The Contractor shall follow standards and practices so that software will be portable across a wide range of hardware configurations over the system lifetime. Portability provides the ability to move applications and data from hardware platform to hardware platform without the need to rewrite applications or perform manual data conversions, and allows progressively more capable system software or upgraded COTS software products to be implemented without requiring major changes to applications software.

The Contractor shall develop, select, or assemble representative benchmark test suites and testing procedures for each major hardware or software acquisition. Benchmarks shall be designed and used to evaluate both performance and conformance with standards. Designated Government representatives shall be notified not less than five days in advance and allowed to witness and critique all benchmark tests.

Benchmark test suites shall include third party vendor standard benchmarks and actual science algorithms (or simulated science algorithms) used in the ECS program.

2.4 Review Process

The ECS design review process has been defined to allow the ESDIS Project and|CN02 representatives of the Earth science community to review the developing ECS design at key points and to provide feedback to be incorporated into the development activity. A significant feature of this review process is that overall system design concepts will be reviewed early in the program and used as the foundation for subsequent design reviews of each for the major system Releases. The different reviews described in this SOW will be held at different levels of detail, allowing the participants in each review to be chosen with regard to their backgrounds, responsibilities, and abilities to contribute to the subject matter of the particular review. The major reviews in the ECS review cycle are diagrammed in [Figure 2.4-1](#). These reviews are described below and further detailed in Section 3 and those in the development process are detailed in GSFC 420-05-03, ECS Performance Assurance Requirements for the EOSDIS Core System. The purpose of these reviews is to:



Legend:

- CDR Critical Design Review
- CRR Capabilities and Requirements Review
- IDR Incremental Design Review
- PDR Preliminary Design Review
- PMR Program Management Review
- PRR Prototyping Results Review
- RRR Release Readiness Review
- SDR System Design Review
- SRR System Requirements Review

**Typical ECS Release
Review Cycle**

NOTE: CSR and RIR not shown
Incremental Reviews not shown

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Figure 2.4 - 1 Conceptual Relationships of Major ECS Reviews

- a. Review delivered and accepted capabilities;
- b. Identify major changes required;
- c. Establish priorities for the next release;
- d. Review user satisfaction;
- e. Serve as an evolutionary development check point;
- f. Demonstrate that the next planned release meets system requirements;
- g. Demonstrate that compatibility exists among the ECS segments and their elements.

The initial reviews, the Project Management Review (PMR), System Requirements Review (SRR), and System Design Review (SDR), will be conducted at the system level, assuring that overall system concepts are reviewed and agreed upon early in the program. These reviews will be followed by the Preliminary Design Review (PDR), reviewing the design of each ECS segment. The PDR will be followed by Critical Design Reviews (CDRs) for each element in the ECS. At each of the descending levels in the review process, from system to segment to element, the scope of the review will narrow to become focused on smaller portions of the ECS, while the discussion material will be more detailed. This is intended to permit complete oversight of the planning, design and implementation at increasing levels of detail. This review approach parallels the traditional SRR, PDR, and CDR reviews used for most large systems with iteration for the multiple releases of ECS.

Prototyping Results Reviews (PRRs) will be held to provide results of specific prototyping activities. The PRRs will be timed to mesh with the points in the development cycle where information regarding the prototype (or prototypes) will be needed. Before the delivery of each release to the operational sites, a Consent to Ship Review (CSR) will be held to present the results of release testing at the Contractor's development facility and to determine whether the release is ready to be delivered to the operational sites for testing. Following system acceptance testing at the operational sites, a Release Readiness Review (RRR) will be held to present the results of site release testing and to determine whether the release is ready to be delivered, installed, and incorporated into the operational system. The RRR is the last of the major reviews for a release.

The review cycle includes a series of EOSDIS Capabilities and Requirements Reviews (CRRs) which will be held at the Project level. The CRRs will review the overall EOSDIS development plans and determine whether the requirements for the next ECS release cycle need adjustment before beginning specific design and development work. For each release after Release A, a system-level Release Initiation Review (RIR) will be held to establish the baseline|CN05 for initiating the next release cycle. This will allow for the incorporation of feedback from prototyping and prior release experience into the development cycle. The RIR for Release A will|CN05 be presented at the SDR. As work on the next release starts, Incremental Design Reviews (IDRs)|CN05 will be held to evaluate the segment designs planned for the next increment in the system evolutionary cycle. The IDRs represent updates to the original segment PDRs and add detail related to the next release. After the IDRs, the review cycle for the new release continues with the element CDRs and another RRR.

The review cycle is intended to allow the Government and ECS users to critique the design at critical points in the development process. It also is intended to allow the results of prototyping to be discussed and injected into the ongoing system development process. The ECS review, design and development process is also intended to ensure that changes are incorporated into the system in a disciplined and controlled manner. Changes to the ECS Specification or system design that are necessary as the ECS evolves will be controlled by the ESDIS Project. |CN02

The Contractor shall identify other internal reviews and activities that support preparation for the reviews described above. The Contractor shall provide at least 30 working days advanced notice to the CO/COTR of internal reviews leading up to the major reviews. Internal reviews, dry runs, or walkthroughs of major reviews shall be attended by NASA and other EOS representatives, as mutually agreed to by the COTR and the Contractor's ECS Program Manager.

2.4.1 EOSDIS Project Level Capabilities and Requirements Reviews

CRRs will nominally be a series of reviews of EOSDIS requirements, including ECS requirements, and the emerging system capabilities being developed to satisfy these requirements. The CRRs will address user experience with the current operating Version of EOSDIS (including the ECS), the progress and results (including user evaluation) of Government and Contractor prototyping and study efforts, progress on investigator algorithm software development and

testing, and definition of new requirements, or modifications to existing requirements for the next Version, including new, or modifications to, requirements for the ECS.

The Contractor shall take the lead in supporting the Project by arranging for meeting rooms and other accommodations and necessary coordination for the CRR. The Contractor shall administratively support the Project by taking minutes and recording action items at the CRR. In addition, the Contractor shall support the CRRs by presenting ECS-related information as required by the Project. CRR Input Materials shall be prepared in accordance with DID 221/SE2.

2.4.2 ECS System-Level Reviews

Six types of reviews will take place at the system-level:

- a. Project Management Review (PMR);
- b. System Requirements Review (SRR);
- c. System Design Review (SDR);
- d. Release Initiation Review (RIR);
- e. Consent to Ship Review (CSR)
- f. Release Readiness Reviews (RRRs).
- g. EP Readiness Reviews (EPRRs).

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Each of these six types of reviews shall provide a system-level perspective of the ECS. These reviews are briefly discussed in this section, with specific SOW statements for each review included in Section 3.

The PMR will be held to ensure a common understanding of how the ECS development effort will be managed. The schedule for the PMR is given in the Delivery Schedule. The PMR will be followed by monthly project management status reviews for the duration of the contract.

The SRR will encompass a complete review of the ECS Specification and the EOS/EOSDIS Requirements (Level 2) that drive the Specification, promoting a common understanding between the Project and the Contractor of the capabilities the ECS must provide. The SRR will be held early in the contract as indicated in the Delivery Schedule.

The SDR will address the top-level ECS design. The SDR will include the definition and high-level design of ECS segments and elements, the interfaces between these and the interfaces

between these and external systems, facilities, users, operators, etc. The SDR will be targeted on the final operational configuration of ECS. The Contractor shall document in the SDR how the results of user experience with EOSDIS Version 0 and results of Contractor and Government prototyping and study efforts have been taken into account. The SDR will be held shortly after the SRR, at the time indicated in the Delivery Schedule.

An RIR will be held for each release beyond Release A to establish the baseline for initiating the next release development cycle. Any results from prototyping and feedback from operational and users' experience with prior releases will be used to establish requirements and priorities for the next release. The RIRs will be held early in the development cycle, at the times indicated in the Delivery Schedule.

The CSRs will address the readiness of an ECS release for delivery to the operational sites for testing. These reviews will address:

- a. Integration and test results at the Contractor's development facility;
- b. The approach for installation and test of the release at the operational sites to ensure that disruptions to ongoing operational services are minimal or nonexistent;
- c. Status of test procedures for operational system integration and acceptance testing;
- d. Status of equipment and staff at the operational sites for release installation.

The CSRs will be held upon completion of ECS system integration and test at the Contractor's development facility, at the times indicated in the Delivery Schedule.

The RRRs will address the readiness of an ECS Release for operational installation. The reviews will address:

- a. Integration test results and acceptance test results;
- b. New capabilities, improvements, and changes;
- c. Status of operations guides, user's guides, and other documentation;
- d. Status of ECS sites and elements and their interfaces and operations that are affected by this Release;
- e. The approach for installation and operational transition to the new Release to ensure that disruptions to ongoing service are minimal or nonexistent;
- f. Software error rates and error resolution rates.

The RRRs will be held at the times indicated in the Delivery Schedule.

The EPRRs occur at the turnover point from the development process to the evaluation process. Incremental developers demonstrate the achievements of the completed EP to Customer and community scientists and managers to build understanding. CN07

2.4.3 Segment-Level Reviews

A Preliminary Design Review (PDR) will be held for each ECS Segment. The PDR shall address the design of the segment-level capabilities and element interfaces through all ECS releases. The PDR shall address Contractor prototyping results and how the results of both Contractor and Government prototyping efforts, studies, and user experience with EOSDIS Version 0 have been incorporated into the ECS design for the Segment being reviewed.

After the PDR for each Segment, subsequent Incremental Design Reviews (IDRs) will be held. IDRs will address designs for the next Release and will be held before starting implementation of that Release. The Contractor shall document in each IDR how the results of Contractor and Government prototyping efforts, studies, and user experience with the currently operating ECS Release are being incorporated into the ECS Segment design of the next Release. The Contractor shall also show how the results of the previous Capabilities and Requirements Review are being incorporated into the design of the next Release.

2.4.4 Element-Level Reviews

There will be a series of Critical Design Reviews (CDRs) for each element in the ECS, with a review conducted prior to undertaking final coding of software for each system Release. Each CDR will address detailed element-level design, including such details as Program Design Language (PDL) for key software modules, and element interfaces for the next Release. The Contractor shall document in each CDR how the results of Contractor and Government prototyping efforts, studies, and user experience with the currently operating ECS Release are being incorporated into the ECS element-level design of the next Release. The Contractor shall also show how the results of the previous CRR have been incorporated into the element-level design of the next Release.

After the first CDR, succeeding CDRs will focus on changes to the ECS design to be incorporated into the next Release. The Contractor shall address design changes on the levels of the system SDR and segment PDR/IDR as well as the element CDR. Thus the series of CDRs

will constitute a mechanism for continuing review and modification of the ECS element-level design to adapt to the lessons learned from prototyping, user experience, and special studies.

2.4.5 Incremental Development Reviews

Reviews for Incremental Development shall be through monthly coordination meetings, where the attendees are ECS project development representatives and ECS Segment customer representatives. A customer selected set of Scientists may also attend (in person or via teleconference). Demonstrations of the software capabilities developed to date may be given as part of the monthly coordination meetings. | CN07

2.4.6 Prototyping Results Reviews

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Prototyping Results Reviews (PRRs) will be held to review the capability provided by the prototype and to reach conclusions concerning incorporation of the prototype into the mainline system development. These reviews shall include independently developed reports from users who have utilized the prototype and who can assess the applicability and suitability of the item prototyped.

2.5 Phased Implementation

The ECS Specification defines functional and performance requirements that shall be met by | CN01 the full configuration of ECS. The Contractor shall implement ECS by a phased process: first defining and preparing toolkits to support investigator algorithm development; second implementing IMS/DADS functions for non-EOS data; third providing PGS capability for integration and test of science data processing software; and fourth supporting EOS launch and orbital operations. The phased implementation is summarized in Table 2.5-1 and Table 2.5-2.

Date	Functionality/Capacity	
Contract Award	Government furnishes ESDIS draft PGS toolkit specification	
4 months After Contract Award (ACA)	Contractor provides draft PGS toolkit spec based on ESDIS specification	
6 mo. ACA	Contractor provides final PGS toolkit spec based on ESDIS specification	
9 mo. ACA	Toolkit: Orbit/attitude simulation tools software documentation (Users Guide)	CN05
13 mo. ACA	Toolkit: error status tools, generic I/O tools, geolocation tools, HDF wrappers	CN05
17 mo. ACA	Toolkit: auxillary/ancillary data tools, memory management tools, metadata tools, time and data conversion tools, HDF interface, additional HDF wrapper tools and additional geolocation tools, and math libraries. Initial algorithm I&T environment Toolkit: generic file access	CNO9
23 mo. ACA	Toolkit: auxiliary/ancillary data, constraints and unit conversions tools, additional metadata tools, Level 0 I/O tools	CN05
28 mo. ACA	Full algorithm integration Toolkit at SCFs, geocoordinate transforms, additional Level 0 I/O tools, additional auxillary/ancillary data tools.	CNO9
Release A	Full algorithm integration Toolkit at PGS	CN05

Table 2.5-1 Pre-Release A PGS Toolkit phasing

|CN05

EOSDIS Core System
Statement of Work

	RELEASE A	RELEASE B	RELEASE C	RELEASE D	CN05 CN05
Information Management and Archive Functions	<ul style="list-style-type: none"> - 125 TBYTE Archive - 8 Site Archive and Information Management Services - Support Migration of V0 Data to 8 Archive Sites - IMS Archive Capacity Functionality to support TRMM, LANDSAT 7 and COLOR MISSIONS - Network Access and Distribution of Data Holdings - Subsetting to Granule Level - Security and Backup Services - Hard Media Shipping and Handling Services - Access to all authorized Users - Interoperable with ADCs 	<p>Full Functionality and Performance, Launch Ready for EOS AM-1</p> <ul style="list-style-type: none"> - All V0 Data Migrated to ECS Archive 	<p>Release B Capabilities Plus:</p> <ul style="list-style-type: none"> - Evolutionary Enhancements 	<p>Release C Capabilities Plus:</p> <ul style="list-style-type: none"> - Archive Capacity for 1 Year of Operations Past End of Contract - Planned Upgrades for Increased Capacity Requirements and Equipment Replacement - Evolutionary Enhancements 	
Science Processing	<ul style="list-style-type: none"> - 3 Site (LaRC, MSFC and GSFC) PGS Services to support TRMM - Full Algorithm Environment for Final I&T and Performance Testing - ESN Interface for Testing 	<p>- Full Functionality and Performance, Launch Ready for EOS AM-1</p>	<p>Release B Capabilities Plus:</p> <ul style="list-style-type: none"> - Full Reprocessing Capacity to Support EOS AM - Evolutionary Enhancements 	<p>Release C Capabilities Plus:</p> <ul style="list-style-type: none"> - Planned Upgrades for Increased Capacity Requirements and Equipment Replacements - Evolutionary Enhancements 	CN05

Table 2.5-2 ECS Phased Implementation

	RELEASE A	RELEASE B	RELEASE C	RELEASE D	CN05 CN05
Mission Operations	<ul style="list-style-type: none"> - Initial Mission Operations Capability for Interface Testing - Support to Early Instrument and Spacecraft Command and Control Testing for EOS AM-1 - ECOM Interface for Testing - Functionality for Flight Operations Segment Institutional Interfaces (e.g., FDF, SN, NCC), EDOS and Ecom 	<ul style="list-style-type: none"> - Full Functionality and Performance, Launch Ready for EOS AM-1 - Full Instrument and Spacecraft Testing Support for EOS AM-1 	<ul style="list-style-type: none"> - Spacecraft Specific Updates to Support EOS PM-1 and AERO - Evolutionary Enhancements 	<ul style="list-style-type: none"> - Spacecraft Specific Updates to Support ALT and CHEM - Planned Upgrades for Increased Capacity Requirements and Equipment Replacement - Evolutionary Enhancements 	
Networks	<ul style="list-style-type: none"> - As Required, Launch Ready for TRMM, LANDSAT 7 and COLOR 	<ul style="list-style-type: none"> - Full Functionality and Performance, Launch Ready for EOS AM-1 	<ul style="list-style-type: none"> - Evolutionary Enhancements 	<ul style="list-style-type: none"> - Planned Upgrades for Increased Capacity Requirements and Equipment Replacement - Evolutionary Enhancements 	CN05
System Management	<ul style="list-style-type: none"> - As Required, Launch Ready for TRMM, LANDSAT 7 and COLOR 	<ul style="list-style-type: none"> - Full Functionality and Performance, Launch Ready for EOS AM-1 	<ul style="list-style-type: none"> - Evolutionary Enhancements 	<ul style="list-style-type: none"> - Planned Upgrades for Increased Capacity Requirements and Equipment Replacement - Evolutionary Enhancements 	CN05
Launch Version	<ul style="list-style-type: none"> - TRMM, LANDSAT 7, COLOR 	<ul style="list-style-type: none"> - EOS AM-1 ADEOS II 	<ul style="list-style-type: none"> - EOS PM, AERO 	<ul style="list-style-type: none"> - ALT, CHEM 	CN05 CN10
System Management	<ul style="list-style-type: none"> - As Required, Launch Ready for TRMM, LANDSAT 7 and COLOR 	<ul style="list-style-type: none"> - Full Functionality and Performance, Launch Ready for EOS AM-1 	<ul style="list-style-type: none"> - Evolutionary Enhancements 	<ul style="list-style-type: none"> - Planned Upgrades for Increased Capacity Requirements and Equipment Replacement - Evolutionary Enhancements 	CN05

Table 2.5-2 ECS Phased Implementation (cont'd)

The following paragraphs provide top-level descriptions of the ECS phased implementation process. The Contractor shall define the process and provide detailed descriptions in the System Implementation Plan. The Early-EOSDIS Program Plan provides more information on the concept of phased system releases.

2.5.1 EOSDIS Versions and ECS Releases

The EOSDIS will be designed, developed, and released as a progressive sequence of Versions. The evolutionary approach will include in the design of the ECS results of EOSDIS Version 0 and will progressively improve and extend the capabilities developed by the ECS Contractor until full functionality and capacity is delivered, tested, and accepted. This approach includes implementation of EOSDIS in major increments, called *Versions*, each being the culmination of a series of ECS releases, in conjunction with incorporation of SCF-developed science data processing software and unique DAAC capabilities.

EOSDIS Version 0 (reference EOSDIS Version 0 Implementation Plan in Section 1.8.2 Reference Documents), to be developed outside the ECS contract, will provide an experience base for the design and implementation of the ECS. EOSDIS Version 0 will enhance science users' access to non-EOS data and will prototype concepts required for the development of subsequent versions of EOSDIS. Version 0 will also integrate an information management service to be evaluated in development of the SDPS IMS.

The ECS shall be designed, developed, and delivered as a series of Releases. A Release shall be a system-wide update to the ECS, delivered and tested as a part of the EOSDIS. ECS Releases will represent the ECS portion of EOSDIS Versions. Some user toolkits developed by the ECS Contractor will be packaged and delivered on a schedule independent of ECS releases as indicated in the Delivery Schedule to facilitate science data processing software development and other development activities occurring in parallel with the ECS.

The Contractor is responsible for delivering all releases beginning with Release A. Contractor-delivered ECS Releases A, B, and C will be used to produce EOSDIS Versions 1 and 2. ^{CN04}

The definition and phasing of ECS Releases will allow for change insertion as necessary. Change will be derived from lessons learned from previous Releases, from new concepts tried out in prototypes, from continuous iteration with the science user community, and from

innovation originating in the general Earth science and computer technology communities. The insertion of changes into ECS development will be accomplished through a controlled engineering and approval process.

ECS system-wide test and acceptance of ECS Releases will involve active participation of the ESDIS Project personnel at institutions hosting ECS elements, the science community|CN02 (represented by the Science Advisory Panel for EOSDIS), science advisory panels at institutions hosting EOSDIS elements, EOS program and project scientists, and, through their experience in using ECS functions in the course of their research, the general Earth science community. As approved by the Government ECS CO/COTR, the Contractor shall incorporate, in subsequent ECS Releases, formally approved improvements resulting from user experience, prototyping, new technology, and study efforts consistent with the requirements for ECS.

2.5.1.1 EOSDIS Version 0

EOSDIS Version 0 will be implemented by the Project, the DAACs, and the science investigators under ongoing review and advice from the Science Advisory Panel for EOSDIS and DAAC science advisory groups. The EOSDIS Version 0 process began in 1990 and will continue until completion of a transition of Version 0 data services to ECS Version 1. Refer to the EOSDIS Version 0 Implementation Plan for a complete description of Version 0 activities.

2.5.1.2 ECS Release A (EOSDIS Version 1)

|CN05

Release A shall provide initial PGS functionality and hardware capacity for early stages of|CN05 science data processing software (algorithm) Integration and Test (I&T), at a site accessible via the ESN by developers. Prior to the delivery of Release A, a preliminary PGS toolkit shall be|CN05 designed, reviewed, and delivered to support algorithm development at the SCFs and to facilitate transportability of algorithms to the PGS. Design of the preliminary PGS tool kit shall be coordinated with the overall ECS design.

Release A shall provide full functionality as required to support the TRMM, Landsat 7 and|CN05 COLOR missions. In addition, Release A shall demonstrate full performance of the ECS, using|CN05 a limited number of data sets (e.g., AVHRR, TOVS, SSM/I, and selected derived GOES data).|CN05 The Contractor shall be responsible for populating the Release A system with suitably formatted non-EOS data, metadata, and browse data from existing sources.

Release A supports migration of Version 0 data and authorized services, supports access to|CN05 the EOS investigator community, incorporates changes from beta testing, expands the scope of user access, and provides regular operational support for data migration

ECS Release A will be the initial ECS component of EOSDIS Version 1 and shall provide|CN05 the functionality and capacity necessary for the ingest, storage, access, and distribution of Earth science data products via a distributed network of DAACs on a routine, operational basis. Information management services shall be implemented at all DAAC sites. Archive functions shall be implemented at a minimum of two DAAC sites for testing. Release A shall also provide|CN05 for interoperability with Affiliated Data Centers (ADCs) and with DAAC local systems. This Release, the previous Release, and subsequent Releases shall provide capacities adequate to meet the ECS performance specification for all functions performed, with the volume of data holdings and level of user activity within the timeframe of the Release. The IMS/DADS capacity of Release A shall be sized to support pathfinder and existing Earth science products handled by|CN05 EOSDIS Version 0.

The ECS Release A shall provide the PGS functionality and capacity necessary for final I&T|CN05 of the algorithms (developed and initially tested at the SCFs) in an operational production environment accessible via the ESN by developers. Release A shall be capable of accepting|CN05 NOAA data products necessary for I&T of the algorithms.

The results of Government and Contractor prototyping and special studies and user experience shall be incorporated in Release B. |CN05

Release A shall include standard interfaces to allow interoperability with ADCs. ECS|CN05 Release A shall be capable of accepting, maintaining, and providing EOSDIS users access to| non-EOS directory-level metadata (provided in an EOS-compatible data format by the ADCs) in a manner fully integrated with EOS directory-level metadata for searching.

As a minimum, the following data centers will be EOSDIS ADCs:

- a. DELETED |CN08
- b. NOAA data centers, including the University of Wisconsin.

ECS Release A shall include the capability for the CIESIN to access the ECS IMS functions|CN05 and obtain delivery of high-level EOS products, and for EOSDIS users to access the CIESIN IMS-equivalent and obtain services provided by CIESIN.

ECS Release A shall include an interface to the services of the University of Wisconsin IMS-|CN05 equivalent, including GOES data catalog and ordering functions, allowing EOSDIS users to place requests for off-line delivery of GOES data. ECS Release A shall include two-way|CN05 interoperability with other NOAA data centers, to the extent practical, with existing NOAA IMS-equivalent capabilities. This interoperability will be expanded in EOSDIS Version 2.

Release A shall include mission operations capabilities as necessary to begin initial external|CN05 interface testing.

ECS Release A shall include distributed operations capacity necessary for TRMM. |CN05

Release A shall provide initial PGS capacities at each DAAC site for local integration of the|CN05 algorithms into the operational environment.

ECS Release A shall provide capability to support early command and control testing and the|CN05 command and control functions required by the EOS AM spacecraft and instruments during integration and test. EDOS and Ecom interface testing shall be fully supported. This release|CN02 shall also support interface testing with FDF, NCC, and the spacecraft simulator. ECS|CN01/CN02 Release A shall also include toolkits. |CN05

2.5.1.3 DELETED |CN05

2.5.1.4 ECS Release B and Release C (EOSDIS Version 2) |CN05

ECS Release B represents the initial EOS AM launch ready configuration of ECS, including|CN05 functionality described by the ECS Specification for mission operations and the capacity to|CN01 perform initial post-launch science processing for EOS AM, in addition to the functions, services, and data provided by previous Releases. ECS Release B shall also have the capacity to support|CN01/CN05 I&T of new science algorithms and ECS upgrades in parallel with production operations.

ECS Release C shall incorporate the benefits of evolutionary experience gained from mission operations using Release B. It shall provide the full capacity for processing and reprocessing for EOS AM. Release C shall incorporate the results of continued prototyping and new technology.

2.5.1.5 ECS Release D

ECS Release D shall include the final hardware capacity deliverable under this contract, all fixes, enhancements, and evolutionary changes under this contract, and final “as-built” documentation.

2.5.2 EOSDIS Version 0 Relation to ECS

This section discusses how the Contractor shall incorporate selected data and capabilities from EOSDIS Version 0 to ECS Release A (Version 1) and subsequent transitions to later ECS Releases.

An overall requirement is a coherent, well planned transition from the users’ point of view. Specifically, users must see access to more data and to improved services, new functions, and better performance as the positive benefits off-setting the need to adapt to a new system. Degradation of data services shall be minimized during transitions.

Beginning immediately after Contract Award, the CO/COTR will provide the Contractor with access to the EOSDIS Version 0 Project resources, including documentation, Version 0 meetings, and EOSDIS Version 0 system functions and services.

The CO/COTR will also provide to the Contractor immediately after Contract Award a EOSDIS Version 0 Report summarizing EOSDIS Version 0 work on standards analysis and definition.

The Contractor shall examine EOSDIS Version 0 results and experiences and perform an analysis of Version 0 that documents:

- a. The standards recommended by the Contractor for ECS in areas such as user interface, data formats, data packaging, metadata content, etc.;
- b. The products handled by each DAAC, including projections for additional future data;

- c. The metadata and browse data describing the data products at each site and their compatibility with recommended ECS standards;

The Contractor's ECS design shall specifically address how and to what extent EOSDIS Version 0 data, concepts, approaches, standards, hardware, software, etc. are being incorporated into the ECS.

The Contractor shall accomplish the migration of scientific data, associated browse data, and descriptive metadata (or metadata-only as necessary) from EOSDIS Version 0 to ECS Release A |CN05 in a cooperative effort with the supplier of the data. Responsibility for effective migration, however, shall be with the ECS Contractor. Where it is found that non-EOS data products to be ingested into ECS are not in conformance with ECS standards, the Contractor shall provide engineering support (WBS 2.7), as directed by the Government, for the translation of such data.

Release A shall be delivered with a subset of Version 0 data for access by the science community. Total migration of metadata and data from EOSDIS Version 0 to ECS Release A |CN05 will commence when ECS Release A delivery and Government acceptance is complete. As data migrates into ECS, users shall be provided access commensurate with ECS functions and performance. ECS Release A shall provide the capabilities to perform EOSDIS Version 0 |CN05 functions and services which are incorporated into the ECS design, as well as additional functions not included in Version 0 but required by relevant sections of the ECS Specification.

At each DAAC, as new ECS Release elements are delivered for testing and acceptance they shall be operated in parallel with existing Release elements until testing and acceptance have been completed. ECS users must not experience a degradation in ECS services as a result of introduction of a new Release.

Migration of metadata and scientific data from the existing ECS Release to the new ECS Release will be accomplished as part of the delivery of each new ECS Release. Thus, each new ECS Release will be capable of performing the functions and providing the services of the preceding ECS Release for the same data and metadata, as well as additional functions required to support new capabilities scheduled for the new Release. Migration of existing pre-EOS (or non-EOS) data into the ECS shall begin with Release A and continue through Release B, by which |CN05 time such data shall be accessible via ECS services at ECS performance levels.

2.6 Engineering Development Facility

The Contractor shall develop, maintain, and operate an engineering development facility (EDF). The EDF shall provide a capability for evaluation and benchmark of candidate COTS products, standards, and prototypes. The EDF shall provide an integrated testbed for end to end EOS simulations. In addition, the EDF shall provide development and test tools for system developers.

SECTION 3 — WORK TO BE PERFORMED

3.1 Program Management (WBS 1)

The Contractor shall direct and integrate the program management activities necessary to ensure the successful completion of this contract. The Contractor shall establish an integrated team consisting of the prime contractor and subcontractors. The Government shall be provided direct access to proper individuals within the team for technical exchange, regardless of their company affiliation. Beginning October 31, 1994, the integrated team shall be co-located at a single facility (excluding support at DAAC sites). The Contractor shall perform, as a minimum, the efforts described in the following paragraphs.

3.1.1 Program Control (WBS 1.1)

The Contractor shall establish a management organization with the necessary capability and authority to ensure that contract, technical, schedule, and cost requirements are met. Organizational roles, responsibilities, and lines of authority shall be clearly defined. A full-time Project Manager shall be appointed with the authority to direct contract activities and resolve contractual issues with NASA. The Project Manager shall be given full responsibility and authority to implement all aspects of the ECS development effort as defined by this SOW. Other full-time managers shall be appointed as required.

The Contractor shall establish a Science Office, which provides a focal point for science liaison. A Project Scientist shall be appointed to head the Science Office. The Project Scientist shall report directly to the Contractor's ECS Project Manager, and serve as the project's science advocate.

The Contractor shall maintain its primary interface with the ESDIS Project and ECS Project|CN02 Managers and the CO/COTR and secondary interfaces with the EOS/EOSDIS Program and Project Scientists, the Science Advisory Panel for EOSDIS, DAAC science advisory groups, EOS investigators, and the science community at large.

The prime Contractor shall assure that full management and technical responsibilities are met by subcontractors. The prime Contractor shall provide technical and management oversight and initiate corrective actions.

The Contractor shall establish an Executive Resources Committee, composed of high ranking, senior corporate executives from each team member. Each committee member shall have broad visibility and authority within the company to leverage resources for ECS. The committee shall meet quarterly to review the project and address long term team issues and problems. Specifically the committee shall provide 1) a vehicle at the top of each corporation to ensure the long term project resource requirements are achieved and that ECS obtains the benefit of the best technology from each members corporation, and 2) a mechanism that ensures intercompany team problems are resolved without impact to ECS.

3.1.2 Program Planning, Reporting and Reviews (WBS 1.2)

The Contractor shall produce program plans for accomplishing the work defined by this SOW, and shall perform the work as planned. The Contractor's ECS Project Manager shall meet with the CO/COTR monthly to review overall progress on the contract. The emphasis in these status reviews will include schedule, costs, risks, problems, concerns, performance of delivered items, action items, etc. In addition, the Contractor's intermediate-level managers shall meet informally with their Government counterparts as required to discuss issues.

In addition to status reviews, the Contractor shall prepare and present major technical reviews as required by this SOW. These technical reviews will be attended by NASA Project personnel, representatives of NASA Headquarters, other NASA Centers, the Science Advisory Panel for EOSDIS, DAACs and ADCs, other NASA contractors such as the EDOS or Ecom contractors,^{CN02} and others who have an engineering or scientific involvement with the EOSDIS. The emphasis of these reviews will be the technical characteristics of the ECS, results of prototyping activities and special studies, and interfaces with other systems or interfaces with EOSDIS users.

Formal reviews given by the Contractor will be held with a Government Review Board in attendance. The formal reviews are those summarized on Figure 2.4-1. The composition of the Government Review Board may be different for different types of reviews. The board will generate Review Item Discrepancies (RIDs) to document specific problems, concerns, questions, and suggestions. The Contractor is required to prepare written responses to these RIDs and

provide the responses to the Board for final disposition. At the option of the Board, the RID responses will be presented by the Contractor to the Board in a special meeting scheduled for this specific purpose.

The Contractor reviews shall consist of the required documentation, presentation material, and an oral presentation with a question and answer session. To ensure the inclusion of ongoing prototyping activities in the system development process, formal reviews shall be preceded by related prototype system demonstrations and discussions of the potential effects of the prototype development on ECS implementation. At least five work days prior to each review, the Contractor shall establish an agenda for review and approval by the CO/COTR. All documentation pertaining to a review must be delivered to the CO/COTR either 2 weeks prior to the review (to allow for distribution) or at the review.

The Contractor shall provide facilities for reviews in the immediate GSFC area. Occasionally, at CO/COTR discretion, reviews may be held at other locations of significance to EOS (e.g., DAAC sites). The Contractor shall be responsible for recording the minutes of each review. The minutes shall include comments, recommendations, and action items. The Contractor shall formally submit the minutes of each review session to NASA within one week after the conclusion of each review. The Contractor shall establish a mechanism for documenting and tracking action items resulting from the reviews. The Contractor shall distribute minutes to individuals and organizations appearing on a Government-provided list.

In addition to Board RID actions, the Contractor shall maintain a record of review comments received from each review and the subsequent response to those comments. Activities that could generate comments which must be tracked in this manner include each of the design reviews, prototype reviews, and monthly progress reviews. One month after each review, the Contractor shall provide a report documenting any review comments received and the plan for responding to those comments (included in Monthly Progress Report). The status of progress against the response plan shall be reported at least quarterly throughout the contract period. This information shall be maintained in a database which can be electronically exchanged with the Government.

3.1.2.1 Program Plans

The Contractor shall produce formal plans that will govern the approach taken by the Contractor on the critical activities in this contract, such as overall program management,

configuration management, software development, prototyping, system operation, system maintenance, and other similar activities. These plans, defined in greater detail in various sections of this SOW, shall be submitted to the CO/COTR for review and approval and shall be prepared to be compatible with, but not necessarily identical to, similar plans employed by the Government at GSFC. As applicable, the Contractor's in-house techniques and procedures will be incorporated into these plans. In developing these plans, the Contractor should carefully consider the GSFC Mission Operations and Data Systems Directorate (MO&DSD) policy documents, Military standards for system and software development, and NASA-STD-2100-91. Taken together, these documents represent a collection of good engineering practices that should be applicable to much or all of the ECS. This instruction to use these documents for general guidance does not relieve the Contractor of responsibility for absolute adherence to specific items in these or other documents where so directed by other parts of this SOW.

The Contractor shall prepare and maintain an ECS Project Management Plan in accordance with the requirements of DID 101/MG1 and shall submit the plan to NASA for review and approval. As applicable, the Contractor's in-house methodologies for management of this type of contract will be incorporated into the Project Management Plan. After approval of the Project Management Plan, the Contractor shall utilize the contents of the Plan in performing ongoing management of the work performed on this contract. Subsequent to each ECS release, the Contractor shall revise the ECS Project Management Plan as necessary to reflect the new baseline system and technical approach to the development of the next release.

The Contractor shall review and propose for CO/COTR approval, any needed changes to the Contract Work Breakdown Structure (CWBS) to make it accurately define the way the Contractor will aggregate costs on this contract. The CWBS shall be structured to aggregate development costs to each element and prototype costs to each prototype. Any proposed changes to the CWBS shall be approved by the CO/COTR before being included in the CWBS. Work under this contract shall be performed and reported in accordance with the CWBS approved by the Government. Throughout the life of this contract, the Contractor shall maintain the CWBS in accordance with the GSFC Handbook for Preparation and Implementation of Work Breakdown Structures. The CWBS shall reflect the current status of negotiations, new work, modifications or changes to the SOW or ECS Specification.

The Contractor shall produce milestone schedules for accomplishing the work defined by this SOW, and shall include these plans and schedules in the ECS Project Management Plan

(DID 101/MG1). If work progress does not conform to the Plan, modifications to the Plan shall be proposed by the Contractor for the CO/COTR's approval. After such approval of the proposed revisions, the revised plan shall be employed by the Contractor.

3.1.2.2 Progress Reports

The Contractor shall be responsible for the monthly progress reviews and weekly technical meetings as defined in this SOW. The Contractor shall prepare Monthly Progress Reports in accordance with DID 111/MG3. As part of this report, the Contractor shall provide a schedule of their upcoming technical and engineering meetings, internal reviews, and draft versions of documents. This will enable cognizant Government personnel, EOS investigators, and other invited parties to attend meetings and reviews and to obtain draft copies of documents as they become available. The Monthly Report shall also include agenda for internal review meetings.

The progress reviews shall cover technical, schedule related, and resource aspects of the program. The Contractor's responses to user comments and requests shall be included in the review of technical progress to ensure the desired evolution of the system. Emphasis will be placed on the accomplishments for the concluded reporting period, the planned activity for the next reporting period, and the identification and resolution of issues and problems.

Unless otherwise specified by the CO/COTR, during the design and development stages, reviews shall be conducted in the GSFC area. During the integration and test stages, reviews shall be conducted at locations as defined by the CO/COTR, including facilities undergoing integration and test.

In addition to the formal monthly reviews, informal meetings shall be held weekly with the technical monitors of each element or area (systems engineering, operations, etc.). The emphasis in the weekly meetings will be technical, rather than programmatic. These sessions will be organized and conducted by the CO/COTR for the purposes of keeping abreast of changing requirements, discussing design solutions, anticipating problems, coordinating Contractor activities with related Government or other contractor activities, and serving as a general forum for the exchange of ideas and sharing of expertise between the Government and the Contractor. The Contractor personnel attending these reviews shall be limited to key individuals.

3.1.2.3 Program Management Review

The Contractor shall prepare and present a Program Management Review (PMR). This review shall emphasize the Contractor's approach to the job, the planned flow of system development, the identification of critical development areas, and the cost and technical reporting methodology. The data products scheduled in the ECS Contract Data Requirements List (CDRL) of the CDRD for delivery prior to PMR shall be made available for review at the PMR.

3.1.3 Financial Management (WBS 1.3)

The Contractor shall submit NASA Financial Management Reports 533M and 533Q as required by the NASA Contractor Financial Management Reporting clause of this contract, DID 119/MG2, and Handbook NHB 9501.2B.

The Contractor shall implement a Performance Measurement System (PMS) and provide accurate monthly Performance Measurement Status Reports (PMSRs) in accordance with Goddard Handbook (GHB) 5112.1, Performance Measurement System Handbook, and with DID 109/MG3 of the CDRD. The PMSR shall include a Manpower Plan versus Actual Report. |CN04

3.1.4 Procurement Management (WBS 1.4)

The Contractor shall provide for the selection, procurement, and management of subcontractor efforts. Subcontractor-developed components shall be managed and reported to the CO/COTR in a manner identical to components developed by the prime Contractor. The Contractor shall prepare a Procurement Management Plan, in accordance with DID 110/MG2, which will document procedures to be followed in preparing procurement documentation, managing the competition or selection of the vendor, debriefing losing vendors, executing the procurement, maintaining traceability of subcontractor data, and evaluating and accepting the vendor product.

3.1.5 Configuration and Data Management (WBS 1.5)

The Contractor shall follow a formal change control procedure when updating contract and/or deliverable documents. Documents are categorized into three levels as follows:

- a. Level 1 documents are formal contract deliverables which require CO/COTR review and approval prior to their acceptance and use. Changes to these documents also require CO/COTR approval prior to acceptance and use. These documents shall be under Contractor Configuration Control Board/Configuration Management Board control. At the option of the Government, a few key documents will be designated to be under full Government Configuration Control Board (CCB) control. Changes to these designated documents require CO/COTR approval before they become effective.
- b. Level 2 documents are contract deliverables which do not require formal CO/COTR approval. They must be delivered to the CO/COTR for review and changes may be requested by the Government reviewers.
- c. Level 3 documents are to be identified, reviewed, and controlled by the Contractor. The Contractor shall provide titles and release dates for these documents to the CO/COTR in advance of their publication so that Government personnel can obtain copies.

Delivery to the CO/COTR of level 1 and level 2 documents shall be done by the Contractor in accordance with the CDRL of the CDRD or as revised by the CO/COTR through negotiation with the Contractor. The Contractor's timing and method of distribution shall ensure that the documents are received by the designated individuals and organizations on the distribution list by the due date for the document in the most cost effective manner available.

3.1.5.1 Configuration Management

The Contractor shall establish and implement a configuration management (CM) program to document and control configuration of ECS documentation (requirements, specifications, ICDs, etc.), system and element hardware, software, and support equipment. The Contractor shall produce an ECS Configuration Management Plan in accordance with DID 102/MG1, the ECS Performance Assurance Requirements (PAR) document, and the Earth Observing System Configuration Management Plan, 420-02-02.

The Contractor's CM Plan shall include descriptions of the Contractor CM organization and the procedures to be followed to identify baselines and to control changes. The Contractor shall prepare a Configuration Management Procedures document in accordance with DID 103/MG3 describing the detailed procedures the Contractor will use to ensure control of the ECS systems and their configuration. The Contractor's ECS program management, ECS development, and ECS M&O organizations shall work together to implement comprehensive configuration management procedures that will satisfy the needs of development activities as well as the needs of maintenance and operations activities that will be performed throughout the contract period.

The CM Plan must address all aspects of the system for which the Contractor is responsible. It shall provide procedures for the control of system design and the implementation of that design into the system elements, integration of those elements into the completed ECS, operation of the system, maintenance of the system hardware and software, and sustaining engineering. It shall encompass system hardware, software, and documentation.

3.1.5.2 Data Management

The Contractor shall provide deliverable documentation as specified in the ECS CDRD. The Contractor shall establish and implement a data management system for the collection and dissemination of the Contractor-generated data and drawings. The system shall include a repository within the Contractor's facilities to provide physical storage and access to Contractor data.

The Contractor shall prepare an ECS Data Management Plan in accordance with DID 104/MG1 to define the Contractor's data management system. The documents called for in this SOW and the CDRD represent key documents of interest to the Government but do not comprise the full suite of ECS documentation. The ECS Data Management Plan shall include the Contractor's plan for additional documents required to adequately document the ECS.

The Contractor shall describe the procedures for collecting, maintaining, and controlling all data used in the development of the ECS and shall generate an ECS Data Management Procedures document in accordance with DID 105/MG3.

The Contractor shall prepare a comprehensive schedule plan, the Schedule Management Plan, in accordance with DID 106/MG1. This plan shall describe the scheduling system and explain/describe the program administrative and the schedule administrative control.

The Contractor shall maintain baseline software versions and baseline document versions in controlled libraries. Versions shall be uniquely identifiable and recoverable by name. In addition to design documentation, the Contractor shall include in the documentation library meeting minutes, review presentation materials, technical directions, design notes, correspondence, progress reports, background information, and any other material related to the program, filed in a readily accessible manner.

The Contractor shall maintain distribution lists for various classes of documentation and disseminate documentation and updates accordingly. The Contractor shall clearly identify and date document update pages. The CDRD (see *Applicable Documents 1.8.1*) specifies the Format and Standards Requirements for delivered documentation. Alternative format specifications will be submitted for approval.

All final documents shall be delivered in hardcopy form and recorded on electronic media (e.g., computer disk, compact disk read-only memory (CD-ROM)) in accordance with the approved standards. The Contractor shall take required measures to protect delivered magnetic media (e.g., disks) from infection from viruses. This protection shall apply regardless of the contents of the delivered disks including, but not limited to, documents, data files, and software. The Contractor shall implement measures to detect, report, and eliminate viruses found with the full cognizance of Government personnel.

The Contractor shall prepare and maintain a Documentation Delivery Status Report as part of the Monthly Progress Report (DID 111/MG3). The Documentation Delivery Status Report will provide a means for tracking and controlling the status of deliverable documentation specified in the CDRD.

The Contractor shall prepare a list of milestones that are to be accomplished. This listing shall reflect the milestone, baseline date, and current expected or revised date for accomplishment. In addition, the Contractor shall use the milestone list data to prepare X-Y charts (e.g., actual performance vs. baseline performance). A Milestone Monitoring document shall be developed and maintained in accordance with DID 112/MG3 in conjunction with monthly progress reviews. Other monthly reports are Intermediate Bar Charts (DID 113/MG3), Tabular Reports (DID 114/MG3), 90-Day Window Reports (DID 115/MG3), the Work Packages/Scheduling System Cross Reference Guide (DID 116/MG3), End Item Float Reports (DID 117/MG3), Monthly Analysis (DID 118/MG3), Contractor Cost Reporting (DID 119/MG3), and Monthly Contractor Manpower Reporting (DID 120/MG3).

CN04

The Contractor shall prepare and update as necessary required engineering drawings describing the as-built configuration of the ECS and its segments, elements, subsystems, and components. Drawings shall be prepared in accordance with the approved standards. The Contractor shall retain Computer Aided Design (CAD) files generated under this contract and deliver them to the CO/COTR upon final acceptance of the ECS.

Any formal databases established and maintained by the Contractor during this contract shall be reviewed with the CO/COTR to determine which databases should be provided to the CO/COTR as documented and deliverable end products. The Contractor shall be responsible for assuring the integrity of the databases until database management responsibilities are transferred to the CO/COTR. These databases shall be identified in the ECS Data Management Plan (DID 104/MG1).

In addition to the hardcopy requirements defined in the CDRD, electronic storage and transmittal of documentation, status reports, notes of weekly technical meetings, databases, and similar items shall be used to the maximum extent practical. The Contractor shall provide effort and resources required to support both the physical and electronic delivery of project communications.

The Contractor shall implement and operate an on-line automated ECS Data Handling System (EDHS) that permits users with network access to interactively search and order documentation. The EDHS shall contain official deliverables, management and engineering documents (e.g., open issues, technical reports, meeting announcements) and internal working papers. Users of the EDHS will include project personnel, DAAC personnel, and members of the science community.

3.2 ECS Systems Engineering (WBS 2)

A systems engineering effort shall be established and maintained by the Contractor throughout the contract period of performance to deal with system-level concerns including ongoing changes to system requirements, system architecture, and system design. Segment-level systems engineering efforts shall be established and maintained by the Contractor for each of the ECS segments.

The Contractor's system engineering approach shall include a build/thread methodology that is applied throughout the development life cycle, from operation concepts and scenarios to integration and test.

The ECS systems engineering task, defined in the following paragraphs, shall include systems engineering efforts necessary to ensure the design, development, integration, test, and delivery of a functional ECS that satisfies contract requirements. These efforts shall include planning, scheduling, analysis (including logistics support required), resource allocation, and risk

assessment, as well as any necessary system modeling and simulations. The Contractor shall define and develop interfaces consistent with requirements of the systems comprising the ECS.

The Contractor shall participate in EOS system engineering working groups.

The contractor shall maintain cognizance of the Global Change Data and Information System (GCDIS) Tri-Agency Plan. The contractor shall consider evolving goals and agreements of GCDIS during the ECS design phase in order to minimize future architecture impacts. CN01

The Contractor shall support the Government CCB, providing the necessary system level engineering analyses required to support ECS configuration management activities. Contractor support shall include the performance of commonality analyses to identify hardware, software, and processes that have potential application for common usage among the various ECS systems. These analyses should result in the usage of common hardware, software, and processes throughout the design when permitted by design constraints.

The Contractor shall establish a Risk Management Panel (RMP). The RMP shall be chaired by the Contractor's Deputy Project Manager (DPM). The DPM shall have authority for the team's risk decisions across cost, schedule, and technical dimensions, including corrective actions. The risk management process shall include risk identification, risk estimation, risk evaluation, risk mitigation planning, risk control, and risk monitoring.

3.2.1 Requirements Analysis and Standards (WBS 2.1)

The Contractor shall use the ECS ECS Specification for requirements derivation work. Proposed revisions which amend this document shall be reviewed and, if acceptable, approved by the CO/COTR .

3.2.1.1 Requirements Analysis

The Contractor shall analyze the ECS Specification and allocate the requirements to the ECS segments and elements consistent with the Contractor's architecture and design. As part of this work, the Contractor shall expand the requirements to specify each of the lower-level components that constitute the ECS elements and segments. The Contractor shall trace allocated or expanded requirements to specific statements in the ECS Specification. If any discrepancies between the ECS Specification and higher-level requirements or perceived system needs are discovered by the

Contractor as a result of its requirements analysis, these discrepancies shall be identified as proposed changes to the ECS Specification and submitted to the Government CCB for action.

The Contractor shall review the functional and performance requirements contained in the ECS Specification, the Science References listed in Section 1.8.2 of this SOW, and the EOSDIS Version 0 Report to revalidate the requirements and functions of the ECS segments and elements. The Contractor shall address new or changed user requirements a part of the process. The Contractor shall recommend modification to the ECS Specification where errors or inconsistencies are detected. Recommended modifications to the ECS Specification shall be documented by the Contractor as proposed modifications in DID 216/SE1.

The Contractor shall perform a user requirements study to determine the interface requirements with the PIs, SCFs, and users. The Contractor shall use the results of this study to develop circuit requirements for PSCN and level of service requirements for connections to be provided by NSI and to model the ECS communications (DID 220/SE1). The requirements collected shall also be used with ECS models to determine network and element loading and performance. CN04

The Contractor shall perform a User Interface Requirements Study. This study shall be documented in the Segment Requirements Specification in accordance with DID 304/DV1. CN04

The Contractor shall perform an Instrument Control Facility Requirements Study Report, using the existing ECS Specification as a starting point, to define the control specifications for each instrument to be operated from the GSFC ICF. The Contractor shall coordinate the development of these specifications with the CO/COTR and the individual instrument teams. The study shall be documented in the Segment Requirements Specification in accordance with DID 304/DV1 and updated as instruments change. CN04

As a result of requirements analysis and derivation of lower-level ECS requirements, changes to other Contractor-generated documents (e.g., quality assurance (QA), CM, implementation, operations, system test, data management plans, or life cycle cost estimates) may be necessary. Any necessary updates to these documents shall be generated by the Contractor and submitted to the CO/COTR for information or approval, depending on the configuration control process applicable to the affected document.

3.2.1.2 Support of Standards Efforts

The ECS Contractor shall support the definition of standards for data, software, and communications to be used during the development and operational phases of the ECS program. ECS Standards and Procedures documents that describe the standards and the Contractor's approach for testing, selecting, and implementing them shall be prepared in accordance with DID 202/SE1 and submitted to the Science Advisory Panel for EOSDIS and the CO/COTR for iteration and, if acceptable, approval.

The Contractor shall establish an internal standards working group to maintain liaison with other standards groups, such as the Consultative Committee for Space Data Systems (CCSDS) or other groups identified by the CO/COTR or the Contractor and whose importance is agreed upon by the Government. Specific activities proposed to support this liaison shall be proposed annually by the Contractor and approved by the CO/COTR.

3.2.1.3 System Requirements Review

An SRR shall be held to review recommended Contractor updates to the ECS Specification prior to the establishment of requirements for the ECS design. The SRR will review ECS requirements, architecture, and the allocation of requirements throughout the system and will evaluate the optimization, correlation, completeness, and risks associated with the allocated technical requirements.

The SRR shall also include a summary review of the system engineering process that produced the requirements allocation and summary reviews of the engineering plans for each succeeding phase of the effort. The data products scheduled in the ECS CDRL for delivery prior to SRR shall be made available for review at SRR.

3.2.1.4 Requirements Data Bases

The Contractor shall maintain an on-line technical management database that contains the definitions of all requirements and traces to higher and lower level requirements and related requirements. This database shall be accessible for use by the Government and its support contractors, including the IV&V contractor.

The Contractor shall maintain a recommended requirements data base for providing a focal point for collecting and tracking requirements.

3.2.2 Engineering Planning (WBS 2.2)

The Contractor shall provide the engineering effort and resources necessary to provide system development planning, release planning, the development of facility requirements, and installation planning. In performing this planning, the Contractor shall take into account the characteristics of each facility, including differences in physical facilities or existing equipment (in the case of DAACs), operational roles, type of data handled, and operations staff.

3.2.2.1 Overall Planning

The Contractor shall prepare and maintain an overall System Engineering Plan in accordance with DID 201/SE1. The System Engineering Plan will address the functions and activities necessary to accomplish the systems engineering task. The Contractor shall ensure that engineering efforts (design, systems, and integrated logistics support (ILS)) are totally integrated.

The Contractor shall prepare and maintain a Project Development History in accordance with DID 218/SE3 to document significant events and information related to the development of the system.

The Contractor shall provide an Annual Capabilities, Requirements, and Technology Report, conforming to DID 204/SE3, that evaluates:

- a. The existing ECS hardware and software configurations against commercially available and compatible hardware and software and recommending to the CO/COTR replacement of hardware and/or software when a comparative analysis of cost versus performance so indicates;
- b. The existing ECS system capacity against projected near-term needs, recommending to the CO/COTR capacity upgrades to hardware and/or software as an analysis of needs indicates.

These reports shall contain an assessment of the differences between existing or planned ECS implementations and implementations that would be possible using the most current technology. Specifically, it should address the most advanced, proven technology that can significantly enhance system performance or lower life-cycle cost without reducing system performance. (Any proposed changes that are approved by the CO/COTR shall be implemented into the hardware, software, and documentation by the Contractor.)

3.2.2.2 System Development Planning

The Contractor shall prepare the System Implementation Plan in accordance with DID 301/DV1, for approval by the CO/COTR, to document the Contractor's approach to satisfying the ECS Specification. This plan shall comply with the requirements for the evolutionary process provided in Section 2.1 of this SOW. The plan shall address how the development shall be based on experience gained from implementation of the Version 0 system, and that the resulting system shall incorporate the benefits of experience gained from prototyping efforts performed by the ECS Contractor and others. This plan shall describe the process by which prototype results are incorporated into the system. This plan shall address how parts of the system, such as the user interface, will evolve throughout the development cycle.

The Contractor shall develop an Evaluation Package Strategic Plan to describe the overall plan for developing an increment to support each Evaluation Package, use of selected prototypes, and the transition from Evaluation Package to Evaluation Package.

CN07

The Contractor shall provide the planning necessary to ensure that each ECS segment, element, and subsystem meets requirements for interfacing with the facilities in which they are located. The Contractor shall prepare an ECS Facilities Plan in accordance with DID 302/DV1 (P) 302/DV2 (F) and in accordance with local policies and codes. The plan shall be developed in conjunction with the cognizant facility (e.g., DAAC) personnel. ECS-wide facility requirements and an overall physical plan for ECS facilities and operations areas shall be provided in the ECS Facilities Plan. Actual construction or modification of the facility, such as structural work, building wiring, or cooling, is not the responsibility of this contract. Campus/Center-wide Local Area Network (LAN) cabling will be provided by the individual centers. A Preliminary ECS Facilities Plan for the GSFC site based on the information in Section 1.7 and Appendix B of this SOW shall be included in the proposal and negotiated changes shall serve as the initial basis for Contractor and Government requirements for the facility. The plan shall be consistent with the schedule requirements for facility design and construction.

CN04

The ECS Facilities Plan, especially as applied to the DAACs, shall be responsive to stated plans of the organization providing the facility for accommodating the ECS requirements for that facility. Any discrepancies between such accommodations planned by the host facility and needs

of the ECS Contractor shall be called to the attention of, and will be resolved by, the CO/COTR in accordance with the Government Property clause of this contract.

The Contractor shall produce a Software Development Plan, in accordance with DID 308/DV2, that describes the methodologies the Contractor will use to develop and document the ECS software. The Contractor's plan shall provide a systematic approach to software development that tailors software engineering practices to specifically suit ECS needs.

Software development methodologies, standards, and practices used by the Contractor shall be approved by the CO/COTR. Different methodologies may be employed for different kinds of software developed, e.g., database, real-time, science or engineering data analysis.

3.2.2.3 System Operations Planning

The Contractor shall plan for the operation of the ECS segments and elements and for their necessary support. These planning activities shall include (but not be limited to): the definition of system operations support, operations data management, and operational requirements; the development of operations scenarios and system operations procedures; the definition of multiple site intra-element interface and site-specific operational requirements; and requirements definition of software changes and documentation. Contractor activities for operations planning shall include cooperating and working with the spacecraft and instrument contractors to achieve cost-effective, efficient, and integrated flight operations. The ECS Contractor shall coordinate operations tasks with the EOS Mission Operations Manager (MOM) and the EOS Science Operations Manager (SOM) and provide support to EOS operations working groups. ^{CN02}

The Contractor shall prepare an ECS Operations Concept Document in accordance with DID 604/OP1. The ECS Operations Concept shall be developed with the goal of minimizing life-cycle costs over the program lifetime while maintaining a maximum level of required system services. The Contractor shall provide in the ECS Operations Concept Document a description of how the ECS will appear to its users, including the assumptions about how operational tasks will be performed on the systems and how the users will interact with the systems.

The Contractor shall develop an ECS Operations Plan in accordance with DID 608/OP1 which shall describe the way ECS will appear to the users/operators, detail how operational tasks will be performed, and identify the training required. The ECS Operations Plan shall define the function of any necessary personnel training facilities and the methods by which newly trained

personnel will be phased into system operations with minimum effect on operations. The Operations Plan shall also include the staffing plans necessary to implement the Contractor's operations concept.

The Contractor shall analyze requirements for ECS training and develop a training program. The Contractor shall provide an ECS Training Plan in accordance with DID 622/OP2 that addresses the ECS training requirements and describes the Contractor's training organization, curriculum, resources, schedule, and training methodology. The ECS Training Plan shall include subcontractor-provided training as applicable. The Plan shall address the qualifications required of the M&O personnel to meet position description skill requirements. The training methodology shall include, but not be limited to, computer assisted instruction, classroom training, supervised on-the-job training, and audiovisual aids including video tape presentations by the subject matter experts. The plan shall also include trainee test and certification procedures.

3.2.2.4 Integration and Test Planning

The Contractor shall perform the necessary tasks to ensure the successful integration of the ECS system hardware and software and the investigator-supplied science production processing software. The Contractor shall develop an ECS System Integration and Test Plan in accordance with DID 402/VE1 and present it to the CO/COTR for approval. After approval by the CO/COTR, this plan shall be followed by the Contractor and shall be updated as necessary to accurately portray the Contractor's responsibilities and planned actions for integration, internal testing, and interface testing of the ECS with external elements. Planning for formal end-to-end testing of the EOSDIS and pre-launch simulation is the responsibility of the ESDIS Project;^{CN02} however, the Contractor shall provide support to integration tests of the instruments and the spacecraft, pre-launch tests, simulations, and data flows. ^{CN02}

The Contractor shall develop a methodology to ensure that design and performance requirements have been met prior to system acceptance and shall document this approach by providing a Performance Verification Matrix in the ECS System Acceptance Test Plan (DID 409/VE1). The System Acceptance Test Plan shall be updated for each release as necessary.

All necessary coordination with the ECS facilities, or facilities in which ECS equipment will be placed, shall be the responsibility of the Contractor. Individual facility integration and test plans shall be provided by the Contractor.

3.2.3 Design and Interface Control (WBS 2.3)

3.2.3.1 System-Level Design

The Contractor shall develop a system-level design for the ECS, including the architecture and concept of operations. On the basis of the design, the Contractor shall define the major system equipment and software necessary to meet the overall ECS Specification. The Contractor shall define his incremental approach to implementing the design compliant with the requirements of Section 2.1, including the development of prototypes and their incorporation into the system in a continuous process of integration and demonstration.

The Contractor shall prepare an ECS System Design Specification in accordance with DID 207/SE1 to document the allocation of system requirements to the ECS segments and their elements and to detail the overall system architecture that will satisfy the requirements. The Contractor's system design shall meet the requirements of the ECS Specification.

The Contractor shall analyze the EOSDIS Version 0 design and shall document this analysis in a Version 0 Analysis Report (Contractor Analysis of Version 0) prepared in accordance with|CN04 DID 206/SE2.

Subsequent to the acceptance and integration of a new ECS Release, the Contractor shall analyze user experience with the release and document this analysis in a Release Experience Report in accordance with DID 332/DV3. These Reports shall include detailed comments, criticisms, and suggestions from the Science Advisory Panel for EOSDIS, DAAC science advisory panels, program and project scientists, and science users and shall provide the Contractor's assessments and responses, including an outline of plans for incorporating the science user feedback documented in the report in the next Release or for prototyping efforts to resolve problems or questions.

The Contractor shall perform trade-off studies and analyses (e.g., cost/performance, modeling and simulation, data flow, make/buy, risk) as required to support design decisions. The analytical data shall be provided to the ESDIS Project in the Tradeoff Studies Analytical Data Report as described in DID 211/SE3. |CN02

As part of this design effort, the Contractor shall develop and deliver overall system schematics, layout, interface requirements, and drawings. Details of the overall design shall be documented in an integrated set of ECS system, segment, element, subsystem, and component specifications.

3.2.3.2 System Design Review

An SDR shall be held to review the Contractor's overall system design prior to his initiation of segment-level preliminary designs. At this review, the Contractor shall justify the preliminary design concepts of the overall ECS system and each ECS segment for the benefit of the NASA review team. The Contractor shall present the results of his review of the technical and operational requirements and the extent to which he proposes to incorporate all, any, or none of the EOSDIS Version 0, as well as early prototype results, adopted approaches and standards, maintainability concepts, and feasibility studies. The data products scheduled in the ECS CDRL for delivery prior to SDR shall be made available for review at SDR.

3.2.3.3 System Release Initiation Reviews

An RIR shall be held for each release beyond Release A to establish the baseline for initiating the next release development cycle. Any results from prototyping and feedback from operational and users' experience with prior releases will be used to establish requirements and priorities for the next release. At these reviews the Contractor shall review the results of ECS developed prototypes and any other related evaluated prototypes. Also, a summary of the experience of users with previous releases shall be presented. The RIR for Release A will be presented at the SDR. |CN05

3.2.3.4 System Consent to Ship Reviews

Before the shipment of an ECS release to the operational sites, a CSR shall be held to address the readiness of the release for delivery to the operational sites for testing. The purpose of the CSR is to:

- a. Review the results of integration and test activities at the Contractor's development facility;
- b. Review the approach for installation and test of the release at the operational sites to ensure that disruptions to ongoing operational services are minimal or nonexistent;
- c. Review the status of test procedures for operational system integration and acceptance testing;
- d. Determine the readiness of the equipment and staff at the operational sites for release installation.

3.2.3.5 System Release Readiness Reviews

Before an ECS release is formally approved for use, a RRR shall be held to validate the utility and suitability of the release. This review shall focus on the degree to which requirements for the release have been satisfied and will consider the current status of interfacing elements and the user support infrastructure within the ECS to ensure that the new release will actually improve overall system operation. In addition to a summary of new capabilities and changes since the last release, the data products scheduled in the ECS CDRL for delivery prior to the RRR for the upcoming release shall be made available for review at that RRR.

3.2.3.6 System-Level Review at the Capabilities & Requirements Review

Annually, a system-level review will be conducted in association with the Project-level CRR. The purpose of the system-level review is to:

- a. Review delivered and accepted capabilities;
- b. Identify major changes required;
- c. Establish priorities for the next release;
- d. Review user satisfaction;
- e. Serve as an evolutionary development check point;
- f. Demonstrate that the planned release meets system requirements;

- g. Demonstrate that compatibility exists among the ECS segments and their elements.

The data products scheduled in the ECS CDRD for delivery prior to the upcoming CRR shall be made available for review at that CRR.

3.2.3.7 Interface Design and Control

The Contractor shall prepare a Methodology for Definition of External Interfaces Document in accordance with DID 208/SE1. The Contractor shall prepare Interface Requirements Documents (IRDs) in accordance with DID 219/SE1 as part of the program planning and design work. These IRDs will define requirements which must be satisfied by each interface.

The Contractor shall lead or support the development of ICDs to the external systems|CN02 supporting ECS (e.g., EDOS) as shown in **Table 3.2.3.5 -1**. The Contractor shall work with the various external organizations represented in the table to plan, document, and coordinate the development of these interfaces. During system design and implementation, the Contractor shall prepare External ICDs in accordance with DID 209/SE1 to document the configuration of external interfaces and to serve as baselines for Government CCB approval and control of the interfaces.

The Contractor shall control internal ECS interfaces and shall participate with others in controlling external ECS interfaces. Control of external ICDs will be maintained by the Contractor under the direction of the Project CCB.

The Contractor shall develop the necessary guides and handbooks (e.g., DID 205/SE1, DID 333/DV1) in accordance with EOS Program and ESDIS Project policy. These documents shall|CN02 define the interfaces between the ECS and the science community. They shall include information related to the interchange of requirements, data, technical support, and software between ECS program management and technical staff and the science community.

Table 3.2.3.5-1 External ICD Responsibilities

	EOSDI S	DAAC*	ADC*	ICC	EXT. NETS	CODE 500 INST	LANDSA T 7	JPL DSN	CN01
EXT. ORG.	S	S	S	S	S	L	S	L	CN01
ECS	L	L	L	L	L	S	L	S	CN01

	CODES 421/422/ 424 Flight	CODES 421/422/ 424 Ground	PI/TL	NOAA	ESA	NASDA STA	TRMM	ODCs	ADEOS II	CN01/ CH10
EXT. ORG.	L	S	S	S	S	S	S	S	S	CN01/ CH10
ECS	S	L	L	L	L	L	L	L	L	CN01/ CH10

L Responsible for leading preparation of ICD
S Responsible for supporting preparation of ICD

* A unique ICD or appendix may be required for each ADC, Other Data Center (ODC), and DAAC

EOSDIS includes Version 0 and SCFs

Code 500 Institutional includes GN, NCC, PSCN, Ecom, FDF, EDOS

CN02

3.2.4 Design Analysis (WBS 2.4)

The Contractor shall perform performance analyses and risk assessments of the ECS design to evaluate the optimization, correlation, completeness, and risk associated with the ECS design and to ensure that the implemented system will meet all the requirements of the ECS Specification.

The Contractor shall prepare a Risk Assessment Report in accordance with DID 210/SE3 that identifies possible high-risk areas in the design, manufacture, integration, or test of the ECS systems and related plans for corrective action. The system risk assessments shall assess the risk involved in achieving technical objectives, goals, and schedules within contract estimated costs and funds. Plans and associated costs to provide corrective action through alternate or backup approaches, if such actions are required, shall be included. The Risk Assessment Report shall be updated prior to each IDR.

The Contractor shall provide the necessary system design, analysis, evaluation, implementation, and testing required to ensure that ECS security is in accordance with NASA and Government directives and guidance. These efforts shall consider ECS security related to personnel, physical security, communications, and computer information. The Contractor shall generate an ECS Security Plan in accordance with DID 214/SE1 to document the Contractor's security approach. Preparation of this plan shall include an initial risk analysis for the ECS. A risk analysis shall be periodically conducted and documented in a Security Risk Analysis Report|CN04 prepared in accordance with DID 215/SE3 and NASA policy.

The Contractor shall analyze the ECS design at all levels to ensure that the final system is logistically supportable in a cost effective and efficient manner throughout the system life-cycle.

3.2.5 Life Cycle Cost Analysis (WBS 2.5)

The Contractor shall establish and maintain a Life-Cycle Cost (LCC) model. The LCC model will be used to conduct cost trade-offs and analyses during system development and throughout the contract performance period. The LCC model shall be developed to be compatible with the ECS Work Breakdown Structure (WBS). The LCC model shall identify life cycle costs including the cost of development, acquisition, operation, COTS licensing, upgrades (including newer versions of COTS software), correction of latent defects, and related system support over the ECS lifetime. The LCC model shall also include the cost of any necessary maintenance subcontracts. The LCC model shall include projections for technology improvements. The Contractor shall provide ECS Life-Cycle Cost Reports in accordance with DID 213/SE2.

The LCC model shall model cost sensitive parameters to provide the Government with the capability to assess cost and schedule impacts of new or modified requirements. Cost sensitive parameters shall include, but not be limited to: new instruments, schedule changes, processing requirements, archive volume requirements, number of granules, number of products and input/output loads. The Life Cycle Cost Model shall be continuously updated with actual performance data. The LCC Model, as well as the results from it, shall be made available to the Government.

3.2.6 Science Interface and Support (WBS 2.6)

The Contractor shall actively interface with, provide information to, and receive science-oriented guidance from the Science Advisory Panel for EOSDIS, DAAC science advisory groups, the EOS Program and Project Scientists, and other ECS-supported projects (e.g. TRMM, Landsat 7, and other Earth Probes). Conflicts regarding guidance received shall be called to the attention of, and will be resolved by, the Project. Any resolutions affecting the terms of this contract must be handled via the CO/COTR. ^{CN02}

The Contractor shall maintain an interface between ECS Project management and technical staff and the EOS science community for the interchange of requirements, data, and technical support. The primary Government contact for science support will be the ESDIS Projects Science Processing Support Office. The Contractor shall also support the science community by participating in meetings of the Investigators' Working Group (IWG) and by providing support for other science-related activities such as standards panels, data users groups, etc. ^{CN02}

The Contractor shall provide interfaces to the Science Advisory Panel for EOSDIS, DAAC Science Advisory Panels, the EOS Program and Project Scientists, and other ECS-supported projects (e.g., LANDSAT 7, TRMM, other Earth Probes), as required. In addition to having these groups review ECS actions, the ECS Contractor shall support working meetings between scientists and the implementors of ECS, so that revisions and improvements to the ECS shall have thorough review by the science community. The primary Government interface for science support will be provided by the EOS Project Scientist. Incorporation of any resulting recommendations into the ECS by the Contractor shall be through CO/COTR approval. ^{CN01}

The Contractor shall establish and maintain engineering liaison with the EOS investigators developing application software for the PGS.

The Contractor shall establish and maintain engineering liaison with the investigators developing software intended for eventual incorporation into the ECS. This liaison will include participation in design and code reviews for the purpose of understanding sizing and other problem areas and for monitoring adherence to adopted standards.

The Contractor, in concert with the ESDIS Project and the CO/COTR, shall foster science community involvement in the ECS development process through educational institutions. Innovative research shall be encouraged in the Earth and computer sciences. The primary

objective of these research efforts shall be to provide insight into technological advances in computer sciences that can serve the evolving long term needs of the Earth science community.

3.2.7 Engineering Support (WBS 2.7)

The Contractor shall provide a broad range of technical activities in direct support of the GS&OP including special studies and analysis, planning, and development. The GS&OP will issue technical direction for tasks determined to be outside direct development and implementation of the ECS, such as: early-phase studies related to programmatic or policy changes, translation of existing data into ECS formats, studies related to potential ECS science products and computational techniques, and studies related to DAAC-unique utilization of ECS data.

3.2.8 Engineering Liaison

An important aspect of the ECS contract is the technical understanding and liaison with other GSFC contractors, Government, and international interfaces, such as the EOS science community, EDOS, SN, Ecom, IPs, local DAAC organizations, and other support contractors (Ref.: Interface Definition Document for ECS). While much of the interface data and information will be provided to the Contractor, direct liaison is also required. The Contractor shall play an active role in ECS-related working groups and technical meetings supporting the EOS mission. |CN02

The Contractor shall provide the necessary services to maintain interfaces with the ESDIS Project and other external organizations and components in support of the ESDIS Project. Contractor contacts with other GSFC contractors and external interfaces shall be coordinated through the CO/COTR. |CN02

Under the purview of the CO/COTR, the Contractor shall establish and maintain engineering liaison with other organizations involved in the definition or development of the ECS. These organizations include, as a minimum, the DAACs, the IWG, instrument development teams, investigator software developers, the spacecraft developers, and the EDOS and Ecom developers. The Contractor shall regularly attend the IWG meetings, to present status reports and other pertinent information. |CN02

The Contractor shall maintain liaison with IPs for activities that interface with the ECS. Specific activities proposed to support this liaison will be reviewed and approved by the CO/COTR.

Full time, on-site DAAC support shall commence within the first six months of the contract. On-site support at each DAAC shall consist of a science representative and a engineering representative, at a minimum. Full time on site support is not required for CIESIN SEDAC. |CN06

3.2.9 Metrics

The Contractor shall develop and implement a comprehensive set of metrics for assessing, monitoring, and improving user satisfaction and productivity throughout the life cycle of ECS. Metrics shall be developed to: 1) measure ECS contribution to NASA's science objectives; 2) enhance science data access and analysis; 3) monitor performance of key ECS requirements; 4) monitor critical interfaces; and 5) monitor major ECS risks.

3.3 ECS Segment/Element Development (WBS 3, 4, 5)

The Contractor shall provide the necessary management and technical efforts required to direct and control the development of the ECS segments and factors. The Contractor shall develop the overall design for the ECS and document it in the ECS System Design Specification (DID 207/SE1). The Contractor shall perform, as a minimum, the efforts described in the following paragraphs.

3.3.1 Segment/Element Development Management (WBS 3.1, 4.1, 5.1)

The Contractor shall manage the activities of planning, organizing, directing, coordinating, controlling, and approving actions. Contractor segment/element management activities shall include such functions as configuration management, documentation, management reviews, change board activity, budgeting, planning and scheduling, contract administration, procurement management, performance management, test program management, quality assurance, and logistics management. The Contractor shall ensure that the management infrastructure, procedures, and policies are in place to support segment and element implementation.

3.3.2 Segment/Element-Level System Engineering (WBS 3.2, 4.2, 5.2)

The Contractor shall perform the necessary system engineering efforts associated with the planning, analysis, design, test, integration, and delivery of the ECS segments and their elements. The segment/element engineering task also includes the activities specified in the following paragraphs and the generation of the technical and planning documents that are products of these system engineering activities.

3.3.2.1 Engineering/Development Planning

The Contractor shall conduct engineering planning studies, control and direct engineering activities, and plan for the engineering changes and system optimization efforts associated with the development of the ECS segments and their elements.

The Contractor shall produce a Segment/Element Development Plan in accordance with DID 329/DV2. This plan will identify the implementation approach for the development of each segment and element, including the development and incorporation of prototypes and the partitioning of the task into builds. The Contractor shall also develop a Segment/Element Release Plan in accordance with DID 307/DV2. The Release Plan will include schedules for the element builds and will map the builds into releases.

In planning the ECS segment/element development, the Contractor shall provide for expansion of system capability and capacity in an incremental fashion, compatible with system capacity and performance requirements.

The Contractor shall identify the process for integrating the ECS elements and verifying that they comply with the design. Element test plans shall include plans for testing at the software unit level. The Contractor shall develop the Segment/Element Integration and Test Procedures in accordance with DID 322/DV3.

For Incremental Development, the Contractor shall prepare an Increment Objectives Plan folder for each increment to refine the technical objectives for the current increment based on the general objectives and guidelines documented in the EP Strategic Plan.

CN07

3.3.2.2 Element/Subsystem Requirements Analysis

The Contractor shall conduct a requirements analysis for each ECS segment and element as identified in the ECS System Design Specification (DID 207/SE1) and allocate the requirements to specific components of the element designs. The Contractor shall specify the functional and performance requirements for each ECS segment/element and its subsystems and components in a Segment/Element Requirements Specification document in accordance with DID 304/DV2.

The Contractor shall define segment, element, subsystem, and component requirements to be compatible with higher level requirements and designs, performance analyses, risk analyses, and cost and performance trade studies.

For Incremental Development, the Contractor shall develop a folder for each increment to describe the overall operations concept scenarios, as appropriate, for the associated Evaluation Package. Segment/element requirements will be derived based on allocated mission critical requirements. As-built requirements for the entire increment shall be subsumed in to Segment/Element Requirements Specification documents in accordance with DID 304/DV2. CN07

3.3.2.3 Element Design

The Contractor shall prepare a Element Design Specification in accordance with DID 305/DV3 (P) 305/DV2 (F) 305/DV2 (U/D) to specify element performance requirements, CN04 provide an overview of the elements and their subsystems, define the structure and design of the element, decompose functional requirements for the elements to subsystems and components, and define subsystem interface requirements. The element design specifications shall define the physical and functional characteristics of the element and subsystem components in such detail as to allow a “buy or build” trade-off to be made. In developing element design specifications, the Contractor shall consider the use of available hardware and software. The design shall employ COTS hardware and software to the maximum extent cost effective. In each case, the Contractor shall provide supporting rationale for any recommendations concerning use of these items. This effort includes the design of an integrated communication capability linking the ECS nodes (excluding the SN, Ecom, and EDOS, which will be separately designed and provided by CN02 NASA).

The Contractor shall generate a detailed design of all components (both hardware and software) of the ECS elements. The Contractor shall generate "code to" or "fabricate to" documents or drawings for each element and subsystem. The Contractor shall provide a Detailed Design Specification in accordance with DID 305/DV3 (P) 305/DV2 (F) AND 305/DV2 (U/D)|CN04 that describes each element/subsystem and decomposes higher-level designs to the unit or component level. The impact of training resource requirements shall be included within each proposed ECS element design and its corresponding staffing profile, and a summary which is cumulative as each element is completed shall be provided.

The Contractor shall generate a Database Design Specification and Database Schema document in accordance with DID 311/DV3. The Contractor shall prepare this document with a recognition that some databases will be shared between different sites of the ECS and with recognition of interoperability with other data bases preexisting or external to this contract. The database design specification shall establish the architecture of element/subsystem databases. The database schema shall provide a detailed description of items in each ECS database, including information on the database manager, database definition, query languages, and database structure.

For Incremental Development, the Contractor shall prepare development notebooks to capture design materials as the design evolves. Development notebooks with as-built materials will be subsumed by the Segment Design Specification (305/DV2) prior to CSR. |CN07

The Contractor shall develop the ICC to meet the requirements of the ECS Specification and derived instrument unique requirements. In addition, the ICC design shall accommodate special instrument operations and analysis tools and capabilities developed by the instrument development and science teams. The Contractor shall define the interface and associated standards between the instrument team-supplied functions and the Contractor-developed ICC. An example of a standard is a user interface definition. The Contractor shall support the integration of the instrument team-supplied functions into the ICC, including:

- a. Review of the interface design of the instrument team-supplied functions;
- b. Support testing of instrument team-supplied integration testing;
- c. Coordination of the resolution of interface problems;

- d. Correction of any deficiencies in its own interface after CO/COTR approval of proposed correction.

The Contractor's ICC design shall include the consideration of efficiencies for multiple ICCs contained in a single subsystem.

The spacecraft contractor will provide spacecraft analysis tools in the form of algorithms and software. The ECS Contractor, in coordination with the spacecraft contractor, shall define the standards and requirements that these tools must meet to allow them to be integrated and operated in the EOC. The Contractor shall implement the algorithms and integrate the software into the EOC.

The Contractor shall design system elements to be capable of growth in processing and storage capabilities in order to accommodate changes and increases in requirements in accordance with Section 1.4 of this SOW. The growth path must be upward compatible such that it is transparent to application software.

Upon completion of the development of the elements of the ECS segments, the Contractor shall document the configuration of each of the segments and their elements, describing their "as built" and "as tested" in the Segment Design Specifications (DID 305/DV3 (P) 305/DV2 (F) 305/DV2 (U/D)). This document shall include the preliminary, final and updated versions of detailed designs.

3.3.2.4 Internal Interface Definition

The Contractor shall define the internal interfaces between the ECS segments and elements such that each ECS segment and element meets requirements for interfacing with the other ECS segments and elements and their facilities. The Contractor shall develop and maintain an ECS Internal ICD document in accordance with DID 313/DV3 (P), 313/DV3 (F) that defines the interfaces between ECS segments and elements. This document shall define the element-level administrative, physical, electrical, software, and data relationships internal to ECS including data flow, transfer rates, and human interfaces or actions.

For Incremental Development, internal interfaces shall be defined in Development Notebooks with the exception of interfaces linked to the Formal Development. Interfaces between a component developed incrementally and a component developed formally shall be documented in an Internal ICD document in accordance with DID 313/DV3. As-built internal interfaces as described in Incremental Development Notebooks shall be incorporated into Internal ICDs. CN07

3.3.2.5 Analysis and Modeling

The Contractor shall identify possible high risk areas in the design, manufacture, integration, or test of the ECS segments and elements and develop alternative, lower risk contingency plans. The Contractor shall assess ways to alleviate development and user acceptance risk by identifying an incremental development process and the evolutionary incorporation of prototypes into the system.

The Contractor shall assess the risk involved in achieving technical objectives, goals, and schedules within contract cost and funding levels. The Contractor shall provide plans and associated costs to provide corrective action through alternate or backup approaches as input to the Risk Assessment Report (DID 210/SE3).

The Contractor shall develop a system model to support requirements analysis, design, and development of the ECS. The model shall include performance of external elements to the extent necessary. The Contractor shall update the model in parallel with system development, simulating the as-developed system to allow performance checking of the completed system and evaluation of any changes proposed as modifications to the completed system. The Contractor shall make the system model sufficiently detailed to permit it to be used to select and validate Automated Data Processing Equipment (ADPE) and the software architecture. The Contractor shall use the model to simulate data flows from instruments to investigators, user interactions with the ECS or with individual instruments, and the processing workload resulting from these activities.

While prototyping ECS functions that interface to the science community, the Contractor shall consult with the EOS Program and Project Scientists, Science Advisory Panel for EOSDIS, ESDIS Project, and DAAC Science Advisory Panels to define scientists' interaction with the prototyping activity. CN02

3.3.2.6 Other Systems Engineering Activities

The Contractor shall prepare an Individual Facility Requirements document in accordance with DID 302/DV1 (P) 302/DV2 (F) that addresses each of the ECS sites. The Contractor shall generate requirements consistent with the facilities actually available at each specific site; the need for additional facility requirements shall be justified. This document shall contain physical layouts of existing equipment as installed in the facilities and show how the new ECS equipment shall be accommodated in the facilities. This document shall also contain the electrical power, grounding, fire alarm, acoustical, and air conditioning requirements. ^{CN04}

The Contractor shall establish and maintain a field office at each DAAC throughout the term of the contract. The Contractor shall use these offices to collect requirements and site-specific information during the early phases of the contract, to support installation and testing during the integration phase of the contract, to provide training, and to provide maintenance and operations, including debugging and other problem resolution, for the remainder of the contract.

The Contractor shall define and document display formats for the elements with significant operator interactions and provide an Operations Scenarios document for those elements in accordance with DID 605/OP2. The Contractor shall also define element and subsystem Operations and Maintenance Procedures in accordance with DID 609/OP1.

3.3.3 Prototype Activity (WBS 3.3, 4.3, 5.3)

The Contractor shall perform prototyping for high risk or uncertain areas and for user sensitive and other areas. The purpose of prototyping is to test and evaluate alternative concepts, approaches, or implementations of ECS functions off-line from ECS. These tests shall be used to determine successful solutions that can then be incorporated into ECS in an orderly manner without disrupting the ongoing ECS implementation or operations activities.

The CO/COTR shall be informed prior to the start of prototyping activities to ensure coordination with NASA and other prototyping activities, in accordance with DID 317/DV1. ^{CN03}

The Contractor shall establish and maintain engineering liaison and analysis with the various DAACs conducting prototyping activities. Initially, this will involve the work performed in support of the Version 0 system being developed as a precursor to this contract. Later, this liaison will involve independent prototyping work that will be performed at individual DAAC

sites. The Contractor shall maintain this liaison throughout the contract performance period. The Contractor shall similarly establish and maintain liaison with Government prototyping activities, as approved by the CO/COTR.

3.3.3.1 Prototype Development

The Contractor shall develop a Prototyping and Studies Plan in accordance with DID 317/DV1 for prototyping and/or special study activities that outlines the approach to be taken, level of effort, and schedule. After any needed revisions to the plan have been negotiated and the plan has been approved by the CO/COTR, the Contractor shall commence the prototyping or study activity according to the schedule. The Contractor shall provide Prototyping and Studies Progress Reports as identified in DID 318/DV3 that describe progress on each ongoing prototyping and study effort. The Contractor shall document each completed prototyping or study effort in a Prototyping and Studies Final Report in accordance with DID 331/DV3. ^{CN03}

Prototype development efforts shall include:

- a. Definition of prototyping to be done in support of system technology development and user interface definition. This shall include determination of the estimated cost to produce the prototype;
- b. Procurement of hardware, software, and other services necessary to develop prototypes;
- c. Unique software and hardware design, implementation, and testing required in the development of prototype system elements.

The Contractor shall maintain a prototyping program that specifically addresses requirements that: 1) cannot be clearly defined at time of contract award, 2) are expected to evolve as system users are better able to define their needs, and/or 3) are influenced by technology advances foreseen and unforeseen at the start of the development phase of this contract (post-CDR). The Contractor shall evaluate prototypes as required in SOW Section 3.3.3.3 before the results are included in the ongoing system implementation.

3.3.3.2 Prototyping Results Reviews and Demonstrations

Upon completion of significant prototyping efforts, the Contractor shall prepare Prototyping Results Reviews (PRRs) which shall include demonstrations of developed prototypes to review the capabilities provided by the prototype and to determine the suitability of the prototype for ECS. The Contractor shall perform performance testing of prototype equipment. Review of the

performance testing results shall be part of the PRR. In preparing these PRRs and demonstrations, the Contractor shall seek participation of users in evaluating the prototype, and shall obtain independent reports from these users concerning the applicability and suitability of the prototype. The Contractor shall include this information in the formal PRRs.

3.3.3.3 Evaluation of Prototypes

Following the PRRs and demonstrations, the Contractor shall analyze the results of prototype demonstrations and generate evaluation reports summarizing test results and user satisfaction with the prototype. This analysis shall include development of plans for applying the developed prototype to the system where the results of the PRR and subsequent analysis indicate this would be desirable from a system performance or user interface viewpoint.

In addition to proposing the incorporation of results of the Contractor's own prototyping activities, the Contractor shall assess the feasibility of incorporating the results of parallel independent prototyping activities conducted by or for the CO/COTR into the Contractor's system development work.

3.3.4 Segment/Element Development (WBS 3.4, 4.4, 5.4)

The Contractor shall manage, control, and produce the ECS segments and elements and the associated software toolkits. This effort includes providing equipment and services not identified as Government-furnished property in the contract or as other institutional services identified by the CO/COTR for support of the ECS.

3.3.4.1 Element Hardware

The Contractor shall plan, coordinate, implement, integrate, and test the ECS system, including portions subcontracted to outside vendors or otherwise produced in facilities external to the Contractor's site. The Contractor shall develop and maintain configuration control of detailed design and construction specifications for any hardware to be fabricated under this contract.

The Contractor shall provide an initial spare parts provisioning for equipment. Spare parts provisioning shall be accomplished in accordance with integrated logistics support described elsewhere in this SOW and described in Replacement Parts List and Spare Parts List (DID 618/OP3).

The Contractor shall make maximum use of COTS hardware. Where the use of custom hardware is required, the Contractor shall:

- a. Identify the need for custom hardware and justify why COTS cannot be used or is not cost effective and/or efficient over the life cycle;
- b. Identify and analyze risks associated with the development and application of the custom hardware over the life cycle;
- c. Develop an implementation plan and schedules for development, production, and integration of custom hardware into the system;
- d. Analyze reliability, maintainability, and system failure rates as a result of employing custom hardware;
- e. Ensure that custom hardware is developed in compliance with the standards applied to the other parts of the ECS;
- f. Secure approval by the CO/COTR.

The Contractor shall acquire and install system hardware over a phased schedule which shall support the buildup of system hardware capability and capacity in an evolutionary manner (see Table 2.5-2).

The number of DAACs is eight but may be increased during the life of the contract. The Contractor's design shall accommodate changes in the number and location of DAACs with no design/architecture impact.

3.3.4.2 Segment/Element Software and Databases

For each of the elements, the Contractor shall define the software requirements, prepare a software architecture design, develop and test the software, and implement the software system design. The Contractor shall develop, code, unit test, integrate and test, and maintain the software required to implement the system design and to meet the functional and operational requirements of the ECS elements. The Contractor shall make maximum use of COTS software, where it can meet the system requirements and provide a reliable, cost-effective, and efficient design. The Contractor shall demonstrate, for CO/COTR approval, the criteria to be met by the COTS or other available software, including:

- | | |
|-------------------------------------|--|
| a. LCC; | d. Licensing Agreements; |
| b. Maintainability and flexibility; | e. Effort to configure for ECS; |
| c. Documentation; | f. Other standards considered necessary. |

The Contractor shall recommend the computer languages to be supported. At a minimum, the Contractor shall be capable of supporting Ada, C, and FORTRAN at the DAAC sites.

3.3.4.3 Toolkits

The Contractor shall develop toolkits meeting the requirements of the ECS Specification and shall tailor the toolkits to accommodate specific user interface needs of the different science disciplines. The Contractor shall build portable software toolkits that operate under a UNIX/Posix-compliant operating system using a standard interface. The Contractor shall develop and support toolkits used at the PGS, FSTs, user workstations, IMS, DADS, SMC, and SCFs. This support includes modifications or upgrades as needed by the evolving system capability or to remedy problems identified by users. The Contractor shall provide only the toolkits and updates to others for use on their own workstations but no tailoring or other special services to support these "external" users. Toolkits shall be delivered as required.

3.3.5 Segment/Element Integration and Test (WBS 3.5, 4.5, 5.5)

The Contractor shall develop a Segment/Element Integration and Test Plan in accordance with DID 319/DV1, detailing the approach and schedule for integrating and testing each segment and element. The Contractor shall integrate subsystems and components (including hardware, software, and firmware) of an element and test that element in its performance of element requirements. The Contractor shall integrate each element (hardware, software, and firmware) into a test environment at each site and test its requirements in this distributed environment. The Contractor shall integrate the elements of each segment and test each segment in its performance of segment requirements. The Contractor shall integrate each segment into a test environment at each site and test its requirements in this distributed environment.

For Incremental Development, the Contractor shall develop an EP/Increment Integration and Test Plan, to identify the integration and test plans required to satisfy the requirements and objectives during Incremental Development. The Contractor shall develop EP/Increment Integration and Test Procedures for each increment to identify integration and test procedures required to satisfy the EP/Increment Integration and Test Plan. Prior to migration to formal development, integration and test procedures for Incremental Development will be consistent with the detail in incremental development notebooks. EP/Increment Integration and Test materials shall be used to develop and/or update the Segment/Element Integration & Test Plan (319/DV1) and Segment/Element Integration & Test Procedures (322/DV3).

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In the case of ECS releases at DAAC sites, the Contractor shall perform the final testing of the release in a test environment at the affected DAAC sites and shall include evaluation by DAAC personnel as part of the final testing. The Contractor shall maintain a cumulative log of software and hardware discrepancies found by the integration team. The Independent Acceptance Test Organization (IATO) shall track the resolution of these discrepancies and shall deliver a monthly tabulation of discrepancies to the CO/COTR in accordance with DID 326/DV3.

The Contractor shall verify and demonstrate the adherence of each system release to designated standards and confirm fulfillment of functional, performance, and operational requirements for the release.

The Contractor shall provide to CO/COTR a Segment/Element Integration and Test Report, prepared in accordance with DID 324/DV3, to document the results of ECS testing for each of the ECS elements and for each of the ECS segments. This document shall address testing of element and segment hardware, software, and firmware.

The Contractor shall participate in a Ground System Integration Working Group to provide a forum for resolving system integration problems (technical or schedule) with other organizations developing portions of the EOS ground system.

3.4 Element/Segment Reviews

The Contractor shall prepare Responses to Recommendations and Action Items (as outlined in the PAR) from each Review in accordance with DID 508/PA1 on a delivery schedule established by the Review Team.

3.4.1 Segment Preliminary & Incremental Design Reviews

A Segment Preliminary Design Review (PDR) shall be conducted for each ECS segment after segment design has been completed. The PDR shall demonstrate that the overall segment design satisfies the complete system requirements for the operational system. A Segment Incremental Design Review (IDR) shall be conducted after segment design has been completed for each upcoming ECS Release. Requirements applicable to the design of the upcoming release shall be reviewed at each IDR. The requirement on each PDR or IDR is to demonstrate that the design of the segment under review satisfies allocated requirements, to present prototyping results, and to evaluate the technical risks associated with the development of the segment and segment elements.

The PDR and IDRs shall address performance issues across ECS segments and their elements and the integrity of specific segment/elements with the overall system design. At each segment PDR or IDR, the CO/COTR will and the Contractor shall:

- a. Review requirements changes since the previous PDR/IDR;
- b. Evaluate the progress, technical adequacy, and risk resolution (on a technical, cost, and schedule basis) of the selected design approach;
- c. Evaluate trade-offs associated with cost vs. performance, build vs. buy, and the allocation of segment functions to hardware and software;
- d. Determine the segment's compatibility with performance requirements of the ECS Specification;
- e. Evaluate the degree of definition of, and assess the technical risk associated with, the selected manufacturing methods/processes;
- f. Establish the existence and compatibility of the physical and functional interfaces among the segments and elements and other items of equipment, facilities, computer software, and personnel;
- g. Evaluate the results of modeling and simulation studies;
- h. Demonstrate how prototyping results are being applied to the design and present plans for any further prototyping evaluations that are needed before finalizing the design;
- i. Assess growth potential of the design elements included in the review;
- j. Evaluate the progress, consistency, and technical adequacy of the selected software design and test approach, compare the estimate of lines of code with the estimate at the previous review, and assess the compatibility between software requirements and preliminary design;

- k. Evaluate the adequacy of any hardware purchase plans, including the hardware product specifications.

The data products scheduled in the ECS CDRL for delivery prior to the upcoming PDR/IDR also shall be made available for review at that PDR/IDR.

3.4.2 Element Critical Design Reviews

When the Detailed Design Specification for an element release is complete, the Contractor shall conduct a Critical Design Review (CDR) for that element. The CDR shall be presented to the CO/COTR prior to undertaking final coding of software for the release. Each CDR shall address element-level design and element interfaces for the next release. The Contractor shall document in each CDR how the results of Contractor and Government prototyping efforts, studies, and user experience with the currently operating ECS Release or EOSDIS Version are being incorporated into the ECS design of the next release. The Contractor shall also show how the results of the previous CDR have been incorporated into the design of the next release.

The purpose of the CDR shall be to:

- a. Demonstrate that the detailed design of the element under review satisfies the performance and functional requirements of the development specifications;
- b. Establish the detailed design compatibility among the element and other ECS elements, facilities, software, and personnel;
- c. Assess element risk areas, including technical, cost, and schedule risks;
- d. Assess the results of the producibility analyses conducted on system hardware;
- e. Review the preliminary hardware product specifications;
- f. Determine the acceptability of the detailed design, performance, and test characteristics of the software design solution;
- g. Determine the adequacy of the operation and support documents.

After the first CDR, subsequent CDRs for the same element shall focus on changes to the ECS design to be incorporated into the next release. The Contractor shall address design changes on the levels of the system SDR, segment PDR, and element CDR. The series of element CDRs shall provide a mechanism for the continuing review and modification of the ECS design to incorporate lessons learned from prototyping efforts, user experience, and special studies.

3.4.3 Incremental Development Reviews and Demonstrations

|CN07

Reviews for Incremental Development shall be through monthly coordination meetings, where the attendees are ECS project development representatives and ECS Segment customer representatives. A customer selected set of Scientists may attend (in person or via teleconference). Demonstrations of the software capabilities developed to date may be given as part of the monthly coordination meetings. | CN07

3.4.4 Element/Segment Test Readiness Reviews

| CN07

The Contractor shall conduct a Test Readiness Review (TRR) at a CO/COTR-approved location for each element and/or segment to be tested for each Release. The TRR shall be conducted after the first element/subsystem has been built, the test procedures have been written and the element/subsystem has been prepared for testing. The TRRs involve reviews of the documentation and results of unit testing to ensure that the software and hardware components are ready for integration testing. The objective of each TRR is to:

- a. Determine that the element test procedures are complete;
- b. Ensure that the Project is prepared for element/subsystem level testing;
- c. Evaluate element/subsystem test procedures for compliance with test plans.

3.4.5 Element/Segment Test Reviews

| CN07

The Contractor shall conduct Element Test Reviews (ETRs) at a suitable location for each element and/or segment following completion of the element-level tests. The reviews shall ensure that elements tested meet system requirements, that the element is operating properly and is ready for integration into the ECS segment, and that test documentation is complete.

For each element the following products shall be reviewed at the Element Test Reviews:

- a. Test Reports;
- b. Performance Verification Matrices.

3.4.6 Other Reviews

| CN07

The Contractor shall conduct other reviews as necessary and as described in the ECS System Implementation Plan (DID 301/DV1).

3.5 Investigator Software Development Support

EOS investigator software development will be accomplished primarily at the SCFs using a toolkit developed by the ECS Contractor. The Contractor shall assist the Investigators as necessary to understand the ECS interface and use the toolkits. Prior to the availability of PGS facilities at each DAAC, the Contractor shall make its ECS development facility available to support a limited amount of investigator software development and software integration and test, specified by the CO/COTR, after the Contractor-site facility can be so scheduled and before the SCF can support the development activity. The Contractor shall operate this facility, make it available to EOS investigators, and provide for data security as required by the ECS Specification. Although the final sizing of each DAAC will not include algorithm development, provision shall be made to allow use of excess capacity for investigator software development on a non-interference basis and in a controlled and scheduled manner. During production operations, investigator software will be developed and tested at SCFs and integrated and tested at the DAAC(s). The Contractor shall develop ICDs (DID 209/SE2 (P) and 209/SE1 (F)) for the PGS-to-investigator software interface for both the PGS and SCF environments. The ICDs shall include, in addition to complete descriptions of software and operational interfaces, an appendix of recommended coding and documentation standards for software to be tested, operated, and maintained in the PGS production environment. ^{CN04}

The Contractor's responsibilities related to integration and test of Investigator-developed science software are listed in Table 3.5-1. This software is to be designed, coded, tested, and validated by the investigators using toolkits and then made available to the Contractor for integration into the PGS production environment. The Contractor shall verify that the Investigator software operates within the PGS production environment. The scientific validity of the data produced by investigator software is not the responsibility of the Contractor. The Contractor shall support the quality assurance and product assurance (PA) of investigator software and software documentation by reviewing, evaluating, and reporting to project.

Table 3.5-1 Contractor Responsibility for Investigator Software

ITEM	ECS Contractor Responsibility
ICD for Investigator software to PGS & SCF	Develops
Investigator software implementation standards	Reviews
Investigator software documentation standards	Defines standards for operations manuals and reviews others
Algorithm definition	None
Investigator software design, code, test, and maintenance	None
Investigator software installation and integration with ECS	Leads
Investigator software science verification	None
Investigator software operational testing	Plans and executes
Investigator software QA/PA	Reviews & evaluates

The PGS services available to Investigators in the development of their science algorithms shall be developed by the Contractor in the Reference Handbook for PGS Services to Science Algorithms prepared in accordance with DID 333/DV1.

3.6 ECS Test and Evaluation (WBS 6)

The Contractor shall develop and implement a comprehensive test program to ensure that the ECS meets requirements of the contract. The Contractor shall prepare a Verification Plan in accordance with DID 401/VE1. The Contractor shall procure and/or develop the necessary hardware and software to accomplish testing. Further applicable requirements for testing are contained in the ECS PAR. The Contractor shall prepare a Verification Specification (DID 403/VE1) to stipulate the specific functions to be demonstrated in each Verification Plan test, Verification Procedures (DID 411/VE1 and DID 414/VE1) to describe the configuration of the test article and how it shall be implemented, and a Procedure for Control of Unscheduled Activities During Verification document (DID 404/VE1) to identify on-going activities not part of the tests and to establish the procedures for controlling them. |CN04

The Contractor shall test the system performance and perform end-to-end testing with other supporting operational elements. The performance tests shall include maintainability demonstrations to be conducted at the Contractor's plant prior to testing of the ECS elements at the element sites.

The contractor test, programs shall include demonstration of interoperability of the CIESIN SEDAC with the other ECS DAACs. |CN06

3.6.1 ECS System Integration and Test (WBS 6.1)

The Contractor shall perform system-level integration and testing of the system, verifying that the system complies with the ECS Specification. To this end, the Contractor shall develop an ECS System Integration and Test Plan (DID 402/VE1) which shall identify the process for integration and the tests for verification of the system. The Contractor shall define system integration and test procedures and document them in the ECS System Integration and Test Procedures in accordance with DID 414/VE1. These tests shall verify correct system functioning, including its interfaces with external elements and systems. Additionally, these tests shall serve to demonstrate the ECS capabilities. A report on the tests shall be issued as an ECS System Integration & Test Report in accordance with DID 405/VE3. Additional Verification Reports (and Software Test Reports) shall be produced after completion of each verification activity in accordance with DID 412/VE2 and DID 405/VE2. |CN04

3.6.2 ECS Acceptance Testing (WBS 6.2)

The Contractor shall develop the ECS System Acceptance Test Plan in accordance with DID 409/VE1 that delineates the tests, acceptance criteria, and schedule for ECS acceptance testing at the system, segment, and element levels. The Contractor shall submit the ECS System Acceptance Test Plan to the CO/COTR for approval.

The Contractor shall establish an IATO (Independent Acceptance Test Organization) that is independent of the developing organization with responsibility for all levels of acceptance testing activities. The Contractor shall prepare an Acceptance Testing Management Plan, in accordance with DID 415/VE1, describing the charter of the organization and detailing the responsibilities, methods, and general procedures to be used by the IATO and how it shall interface with the development organization(s), Contractor management personnel, and the Government.

The IATO shall present test plans, test procedures, test scenarios, and test results reports to the cognizant Government personnel, including PIs and DAAC representatives. The CO/COTR shall be notified of acceptance tests at least three weeks in advance of the test (attendance to witness the tests is at the option of the CO/COTR) and tests shall be conducted at a site convenient to the CO/COTR.

The IATO shall conduct and report on Acceptance Tests (AT) of contractually deliverable hardware and software and major contractor internal builds. The IATO shall define and document the ECS System Acceptance Test Procedures in accordance with DID 411/VE1 and conduct the acceptance tests according to the procedures. Testing shall be conducted by the IATO using documentation produced by the development organization but shall not use development personnel or software tools in the set up, exercise or evaluation of the tests.

The IATO shall document the results in an ECS System Acceptance Test Report prepared in accordance with DID 412/VE2. The Contractor shall deliver the documented results of the IATO Acceptance Tests to the CO/COTR for review at the RRR and subsequent approval.

Final acceptance by the CO/COTR will be based, in part, on IATO test results, the recommendations of DAAC representatives, and the results of IV&V testing. CO/COTR approval and acceptance of an ECS Release depends on the results of the system acceptance tests,

documentation of those tests, other system documentation (e.g., operations, maintenance, training, and logistics documentation) and the operability and maintainability of the new release.

Subsequent to testing, the Contractor shall completely describe variances in the design and "build to" specifications versus the capabilities of the delivered systems. The Contractor shall document these discrepancies in segment Discrepancy Reports (DRs) in accordance with DID 413/VE3.

3.6.3 ECS System Test Analysis (WBS 6.3)

The Contractor shall provide system-wide test analyses based on subelement-, element-, segment-, and system-level test results. These analyses shall include preparation test summary and evaluation documentation.

3.6.4 Support of the EOSDIS System-Level IV&V Program (WBS 6.4)

The Contractor shall provide support as required to the IV&V program and interact with the IV&V provided as follows:

- a. To clarify ECS design, implementation, integration, and test issues;
- b. To attend EOS ground system verification and validation meetings;
- c. To review IV&V-provided test plans and procedures; to coordinate schedules for technical reviews, system installation, and system testing; and to ensure adequate Contractor personnel and equipment (hardware and software) support during IV&V test activities;
- d. For personnel, facilities, and equipment support in the resolution of ECS discrepancies identified during verification and validation testing.

3.7 Performance Assurance (WBS 7)

The Contractor shall provide efforts and resources necessary to ensure that system-wide standards and controls are in effect and are followed during ECS development and operations phases and that safety, reliability, maintainability, and material control programs are part of the system design. The Contractor shall prepare materials related to performance assurance in accordance with DIDs 501 through 535 and some related DIDs 401-415. Specific documents are|CN04 noted in the following paragraphs.

3.7.1 Performance Assurance Program (WBS 7.1)

The Contractor shall establish a Performance Assurance Program in accordance with the ECS PAR for the EOSDIS Core System Document (GSFC-420-05-03). The Contractor shall prepare a Performance Assurance Implementation Plan (PAIP) in accordance with DID 501/PA1 which describes the performance assurance activities to be used to ensure that the delivered products shall comply with ECS requirements. The Contractor shall prepare a Contractor's Practices and Procedures Document in accordance with DID 502/PA2 which describes the Contractor's approach for implementing the performance assurance program. This Practices and Procedures Document shall be submitted to CO/COTR for approval. The Contractor shall ensure that the same performance assurance requirements flow down to subcontractors. The Contractor shall have the responsibility to integrate the vendor and subcontractor performance assurance reports into the performance data requirements submissions for this contract.

The Contractor's Performance Assurance personnel shall participate in ECS reviews. Each month, the Contractor shall prepare and submit a Performance Assurance Status Report in accordance with DID 503/PA3 describing the status of performance assurance activities, deficiencies, and corrective actions. The Contractor shall show that existing-design hardware and previously designed software (COTS) when proposed meet the ECS requirements according to DID 504/PA1.

The Contractor shall establish a resident office with a Quality Assurance Representative (QAR) as a member of the staff at key subcontractors engaged in development activities for the Project. The Government reserves the right to station a resident QAR at the prime Contractor's and key subcontractor's development facilities. Adequate Contractor office space shall be made available to these Government QARs. The Contractor shall perform QA audits on a periodic basis to ensure adherence to established standards and procedures for hardware, software, and operations. Audit Reports shall be produced by the Contractor semi-annually in accordance with DID 506/PA3.

3.7.2 Software Assurance (WBS 7.2)

The Contractor shall plan and implement a Software Assurance Program in accordance with the ECS PAR, GSFC 420-05-03, and guidance can be found in NASA-STD-2100-91. The

Contractor shall ensure that these same requirements are imposed on and implemented by ECS subcontractors who develop software for the ECS segments and elements. The Contractor shall prepare a Software Assurance Plan (SAP) (as part of the PAIP) that describes the Contractor's approach for implementing the software assurance program. The Contractor shall integrate software assurance reports and documentation associated with software provided by ECS subcontractors and vendors into comprehensive data requirements submissions as specified in the performance assurance DIDs of the CDRD.

The ECS Contractor shall identify and allow GSFC access to and use of all software assurance data and data bases generated and collected during the software development and maintenance process. Data to which access shall be allowed includes, but is not limited to, software problem reports, the results of walkthroughs or inspections, RIDs and other review results, and test procedures and results.

Software Performance Assurance personnel shall participate in software design reviews, software audits, software inspections, and software tests as well as any other activities necessary to insure the overall performance of the delivered software product. The Contractor shall document the result of the software product assurance effort in the monthly Performance Assurance Status Report (DID 503/PA3).

The Contractor shall establish a resident office with a Software Performance Assurance Representative (SPAR) as a member of the staff at key subcontractors developing software. The Government reserves the right to station a resident SPAR at the prime Contractor's and key subcontractor's manufacturing facilities. Adequate Contractor office space shall be made available to these Government SPARs.

3.7.3 H/W RMA Program (WBS 7.3, 7.4)

The Contractor shall conduct a hardware Reliability, Maintainability, and Availability (RMA) program in accordance with Section 5 of GSFC 420-05-03. The program shall be oriented toward analyzing engineering design trade-offs and evaluating a system design composed chiefly of COTS hardware, augmented by custom-designed components where necessary. The objective shall be to develop a system design that shall (a) stay within specified maximum down time requirements, (b) meet specified availability requirements for the system and its functions, and (c) optimize reliability and maintainability trade-offs to result in an efficient maintenance and

logistics system which shall provide effective support for ECS system operations. The Contractor shall impose RMA requirements of GSFC 420-05-03 on its subcontractors and suppliers. RMA data shall be maintained in a common-use data base accessible for logistics analyses and other purposes.

The Contractor shall develop and implement an RMA Program Plan in accordance with DID 501/PA1 (describing the PAIP) and the requirements of GSFC 420-05-03. The program shall include mathematical modelling for system availability, as well as reliability and maintainability activities.

3.7.3.1 Reliability Activities

Reliability activities shall include but not be limited to the following tasks as required by GSFC 420-05-03:

- a. Reliability allocations;
- b. Reliability predictions;
- c. Failure modes and effect analysis and critical items list.

3.7.3.2 Maintainability Activities

The Contractor shall conduct maintainability activities as required by GSFC 420-05-03 and ensure that the ECS meets the maintainability requirements of the ECS Specification. The Contractor shall ensure that the overall design minimizes maintenance requirements and the need for associated resources, including maintenance crew labor hours, special tools, and test equipment. The Contractor shall implement the maintainability requirements for the system, review and assess ECS designs and specifications for adherence to the maintainability requirements, prepare Mean Down Time (MDT) predictions for the functional threads found in the RMA section of the ECS Specification, and develop requirements for maintainability verification. The Contractor shall develop plans to ensure that each ECS component can be maintained without necessitating a shutdown of the system once operation of the ECS has begun. The Contractor shall demonstrate that the systems meet the ECS maintainability specifications.

3.8 ECS Maintenance and Operations (WBS 8)

The Contractor shall provide the necessary management and technical resources to direct, control, and perform maintenance and operations (M&O) for the overall ECS. The Contractor responsibility for M&O activities extends to ECS sites and elements at each of the ECS sites and to each of the hardware deliveries and software releases. The Contractor shall be responsible for defining and staffing ECS M&O positions (including management, administrative, engineering, technicians, and operators); defining required prerequisite training and skill, on-the-job training, and formal training, and ensuring that necessary training is accomplished; defining staffing plans and other planning required for a comprehensive maintenance and operations activity. The Contractor shall, as a minimum, perform the M&O tasks defined in the following paragraphs.

The Contractor shall provide M&O personnel at each of the ECS sites to operate and maintain the ECS systems and subsystems (including hardware, firmware, and software) and to perform element, segment, and system functional operations. The Contractor shall provide a level of staffing for maintenance and operations that corresponds to the required support for the different phases, at the specified ECS sites, from development through operational support.

The CO/COTR may negotiate transitions of M&O responsibility from the ECS Contractor to the DAAC sites as agreements are established with the DAAC sites. The Contractor shall support transitions of M&O responsibilities as negotiated, including training of new personnel.

The Contractor shall provide EOS AM operations support per the following table and delivery schedule requirements: |_{CN01}

Table 3.8-1 Operational M&O
(Hours per Day / Days per Week)

	1994	1995	1996	1997	1ST QTR 1998	2ND QTR 1998 to 2002	CN02
Pre EOS AM DAAC/ IMS Releases		8H/ 5D	12H/ 5D	16H/ 7D	16H/ 7D	full operational capability — 24H/7D	CN01
Algorithm I&T		8H/ 5D	12H/ 5D	12H/ 5D	16H/ 5D		CN01
EOS AM Science Operations					16H/ 5D		CN01
EOC/ICC			as re- quired	as re- quired	8H/ 5D		

At DAACs supporting pre-EOS AM missions (i.e. LANDSAT 7, TRMM, COLOR), 24H/7D support shall be provided no later than 3 months prior to launch.

3.8.1 ECS Maintenance and Operations Management (WBS 8.1)

The Contractor shall establish an on- or near-site management organization for GSFC ECS maintenance and operations with field offices at each of the other ECS sites. The Contractor is required to establish an organization that is responsive to the requirements of each site. The Contractor shall prepare a Maintenance and Operations Management Plan in accordance with DID 601/OP1 that describes the management system, controls, functions, policies, procedures, and documentation to be utilized in fulfilling the M&O requirements of each site. The Contractor's M&O team shall monitor the development of the ECS to ensure that the final system and operations plans are compatible and support the overall mission requirements. The M&O team shall ensure that the tools required to perform the maintenance and operations activities are included in the ECS system design and implementation.

The Contractor shall provide the management and administrative resources required at the system, element, and facility levels. Management and administrative activities shall include, but not be limited to, planning, budgeting, accounting, resource management, customer relations, scheduling, and personnel.

The ECS Contractor shall provide the operations support and services necessary to ensure that ECS hardware and software (including COTS) meets required operational capability, for assigned

functions and for interfacing with other subsystems and components of the ECS or external systems as required. The Contractor shall arrange for technical support as needed from vendors of computers, mass storage devices, communications equipment, or any other hardware or software installed at the site. General operations support shall include, but not be limited to, the following:

- a. System and subsystem monitoring;
- b. Product assurance and quality assurance functions;
- c. Status reporting;
- d. Logging/archiving/deloggging in support of ECS anomaly analysis and management of ECS operations;
- e. Verifying operational readiness, including performance measuring and monitoring;
- f. Supporting maintenance activities aimed at fault detection and fault isolation;
- g. Logistics support;
- h. Supporting hardware and software testing and installation.

3.8.1.1 Maintenance and Operations Control

The Contractor shall be responsible for the allocation and control of resources and administrative functions including, but not limited to, finance, personnel, logistics access, property management, security, health, and safety which are compatible with local DAAC site policies and procedures. The Contractor shall provide for ongoing personnel management of the maintenance and operations staff throughout the contract lifetime, including personnel administration, evaluation and promotion, recruiting, and staffing. The Contractor shall provide for finance, accounting, and subcontracting in support of M&O throughout the contract lifetime.

3.8.1.2 Property Management

The Contractor shall prepare a Property Management Plan in accordance with DID 602/OP1 and NASA Equipment Management Handbook (NHB-4200.1C) that provides for the control of Contractor and Government property and for a continuous audit trail from receipt of an item until transfer of accountability or disposal. The Contractor shall have property management responsibility for ECS equipment until it has been accepted by the CO/COTR. In addition, the Contractor shall have responsibility for property management of equipment for which they have M&O responsibility. This requirement includes, at a minimum:

- a. Establishing and maintaining records of property;
- b. Reporting untagged controlled equipment to the NASA Property Administrator;
- c. Assisting the NASA Property Manager in the physical inventory of controlled equipment;
- d. Preparing and distributing monthly transaction reports and quarterly property inventory reports;
- e. Preparing required forms when property is transferred, shipped, disposed of, or modified;
- f. Identifying and reporting equipment no longer required;
- g. Continuing surveillance to ensure that equipment is properly used and physically protected;
- h. Training Contractor personnel on their property responsibilities and obligations.

3.8.1.3 Configuration Management

The ECS M&O organization shall provide configuration management and shall work with the ECS Program Management organization to ensure that a comprehensive ECS Configuration Management Plan (DID 102/MG1) and Configuration Management Procedures (DID 103/MG3) are prepared and implemented.

The M&O organization shall provide technical and administrative support to the Contractor's ECS contract-level CCB, including:

- a. Coordinating usage of approved configuration management procedures with elements and external interface configuration management representatives;
- b. Ensuring that changes to the hardware, software, and procedures are properly documented and coordinated;
- c. Assisting in the development and administration of the library with respect to configuration management procedures;
- d. If requested, providing the recording secretary for the Government CCB;
- e. Coordinating RID requests generated during M&O reviews;
- f. Generating CCB monthly reports;
- g. Preparing agendas for and scheduling CCB meetings.

3.8.1.4 Security

In accordance with NASA Management Instruction (NMI) 8610.22 — National Resource Protection Program, the Contractor shall be responsible for the physical security and control of persons working in and visiting his assigned spaces. The EOC shall be operated as a mission critical resource and the balance of the ECS shall be operated as a mission essential resource.

3.8.1.5 Operational Readiness and Performance Assurance

The Contractor shall be responsible for generating and maintaining an Operational Readiness Plan in accordance with DID 603/OP1 that ensures elements are in a state of operational readiness at all times, including preparations for mission launches and sustaining levels of performance of hardware, firmware, software, and personnel for which the Contractor has M&O responsibility. This document shall include the Contractor's plan for managing Operational Readiness Reviews. The Operational Readiness Plan must provide for regular monitoring of M&O activities under this contract and provide visibility to both the CO/COTR and program management. The Contractor's PAIP (DID 501/PA1) shall include coverage of the operational phase activities of the ECS. Requirements of GSFC 420-05-03 pertinent to the maintenance and operation of the system shall be implemented.

3.8.1.5.1 Operational Readiness

The Contractor shall develop, implement, and maintain staffing, training, scheduling, and testing procedures that ensure continuous operational readiness of the elements/sites for which he is responsible. This requirement includes the development of the Staffing Plan section of the Operational Readiness Plan (DID 603/OP1) and ensuring that staffing is provided according to the plan. The Staffing Plan shall include provisions for the gradual build-up for a Flight Operations Team (FOT) that will assume operations of the EOC from the spacecraft contractor approximately three months after the launch or successful checkout, whichever is later. ^{CN01}

The Contractor shall establish plans and procedures in the Hardware Readiness section of the Operational Readiness Plan (DID 603/OP1) for ensuring the operational readiness of equipment and facilities.

The Contractor shall establish plans and procedures in the Software Readiness section of the Operational Readiness Plan (DID 603/OP1) for ensuring the operational readiness of software and firmware delivered by the Contractor and accepted by the IATO and for externally developed (non-ECS) software which has successfully passed operational verification and operational testing. The Software Readiness section of the plan shall insure that software and firmware management and configuration management activities are implemented on software and firmware maintenance tasks and shall provide rigorous discipline for deliveries, discrepancy reporting, implementation, and tracking. The plan shall ensure visibility into software and firmware status for both the CO/COTR and program management.

3.8.1.5.2 RMA Program

The Contractor shall continue the tasks of the RMA program throughout the operational phase. The activities shall include performance of analytical tasks to cover any changes made in the system hardware, collection of reliability and maintainability data on the system during its operation, and support of refining and updating maintenance and logistics planning and execution, as required by GSFC 420-05-03.

3.8.1.5.3 Segment Operational Readiness Reviews

Segment Operational Readiness Reviews (SORRs) shall be conducted to determine the readiness of each ECS segment to provide services. These reviews shall be held at segment/element facilities to baseline the functional capabilities, performances, and operational characteristics of each ECS segment. SORRs shall concentrate on operational procedures, human interfaces, and the Operational Readiness Plan (DID 603/OP1).

3.8.1.6 General Support

The ECS Contractor shall provide the operations support and services necessary to ensure that ECS hardware and software (including COTS) meets required operational capability, for assigned functions and for interfacing with other subsystems and components of the ECS or external systems as required. The Contractor shall arrange for technical support as needed from vendors of computers, mass storage devices, communications equipment, or any other hardware or software installed at the site. General operations support shall include, but not be limited to, the following:

- a. System and subsystem monitoring;
- b. Product assurance and quality assurance functions;
- c. Status reporting;
- d. Logging/archiving/deloggging in support of ECS anomaly analysis and management of ECS operations;
- e. Verifying operational readiness, including performance measuring and monitoring;
- f. Maintenance activities aimed at fault detection and fault isolation;
- g. Logistics;
- h. Supporting hardware and software testing and installation.

The Contractor shall participate in the EOS operations working groups to provide a forum for resolving issues associated with the operation of the ECS.

The Contractor shall be responsible for the effective allocation, general maintenance, and cleanliness of the space assigned to the Contractor within Government-managed EOSDIS facilities and within facilities managed by non-Government agencies or organizations. The Contractor shall be responsible for those items necessary to operate on a day-to-day basis such as transportation and courier services.

3.8.2 Integrated Logistics Support (WBS 8.2)

The Contractor shall provide a systematic and comprehensive engineering/analytical approach in support of program design engineering and system engineering integration through operations. This support, commonly referred to as Integrated Logistics Support (ILS), shall provide for:

- a. Analysis of design characteristics for integration of support considerations into system and equipment design;
- b. Development of support requirements that are consistently related to design and to each other;
- c. Management of support resources acquisition and utilization through the duration of the ECS.

ILS elements shall include maintenance, supply support, support and test equipment, packaging, handling, storage, transportation, personnel, training facilities, technical data and documentation, and ILS management and engineering support.

The Contractor shall prepare and implement an Integrated Logistics Support Plan in accordance with DID 616/OP2 and a Logistics Support Analysis Plan in accordance with DID 617/OP3.

When required by the findings of the Logistics Support Analysis, the Contractor shall prepare a recommended Replacement Parts List and Spare Parts List in accordance with DID 618/OP3 and a Test and Support Equipment Requirements List in accordance with DID 619/OP3.

The Contractor's logistics support shall consider the utilization of existing site capabilities.

The Contractor shall be a member of and support an Integrated Logistics Support Management Team (ILSMT) as established by the Government.

3.8.3 Segment Maintenance and Operations (WBS 8.3, 8.4, 8.5)

The Contractor shall provide maintenance and operations support for ECS hardware, software, and firmware systems delivered under the ECS contract at the ECS sites. The Contractor shall maintain and operate the ECS until the end of the contract or until the transition to the successor M&O contractor(s), which will occur at different times for different ECS sites. The Contractor shall provide a Maintenance and Operations Transition and Training Plan in accordance with DID 621/OP1 for the transition of maintenance and operations to the permanent maintenance and operations organizations and their contractors. The Contractor shall support and facilitate these transitions by providing training, up-to-date documentation, databases, and any special software or equipment procured or developed in support of M&O under this contract.

The ECS M&O team shall:

- a. Operate and maintain the ECS within the system performance specifications;
- b. Perform operations planning and procedures development, testing, and support to design reviews and operations working groups, such as the EOS Mission Operations Working Group (EMOWG);
- c. Operate and maintain the ECS systems and subsystems at ECS sites. M&O support shall be provided for all phases of the contract, including, but not limited to:
 - 1) Development and pre-launch operations, including archival and distribution of pre-EOS data,
 - 2) Launch through early orbit operations,

- 3) On-orbit operations through contract termination date,
 - 4) Shared and/or coordinated spacecraft operations responsibility with the spacecraft development contractor (approximately L-6 to L+3 months), and |CN02
 - 5) Training of and transition of M&O responsibility to successor contractor(s).
-
- d. Provide flight operations and mission planning support under the direction of the Government MOM and the Project Scientist;
 - e. Provide science operations and planning support under the direction of the SOM and the Project Scientist;
 - f. Maintain an ongoing interface for operations coordination with the IPs, EDOS, FDF, Ecom, TDRSS, NCC, PSCN, NSI, NASA test and simulations facilities, and other external systems and organizations with which the ECS interfaces; |CN02
 - g. Provide vendor subcontract management, dispatch services, courier services, and related support;
 - h. Prepare and maintain periodic summary reports on the status of hardware, firmware, and software;
 - i. Conform to personnel security management policies and directives;
 - j. Cooperate with the spacecraft contractor for the planning, training, and operations of the FOT. |CN02

3.8.3.1 Development of Maintenance and Operations Material

The Contractor shall provide an ECS Operations Plan (DID 608/OP1) covering each of the ECS segments. The ECS Operations Plans shall describe the way each ECS segment will appear to its users/operators and detail how operational tasks shall be performed.

The Contractor shall provide an Maintenance and Operations Manual (DID 607/OP2). This document shall define maintenance and operations requirements for the system elements and describe how the elements and subsystems shall be operated and maintained, including roles and responsibilities of M&O personnel.

The Contractor shall provide Operator's Manuals for each of the ECS elements in accordance with DID 611/OP3. The manuals shall provide the procedures and information necessary to operate each system element/subsystem.

The operational plans and manuals shall include procedures for handling operational anomalies and post anomaly analysis.

The Contractor shall provide Programmer's Manuals in accordance with DID 305/DV3 (P) | CN04 305/DV2 (F) 305/DV2 (U/D) for each of the ECS elements. The manuals shall describe programming aspects of the element computers in sufficient detail to support software sustaining engineering.

3.8.3.2 Maintenance

The Contractor shall provide the resources, personnel, tools, hardware, software, and logistics support required to maintain the ECS hardware, firmware, and software. The Contractor shall provide the capability to modify the ECS hardware, firmware, and software to operate under new host operating systems, to accommodate new hardware, and/or other approved system changes. As a minimum, this shall include the ability to:

- a. Maintain, modify, or repair the system hardware and firmware, including testing the item(s) before returning them to an operational state;
- b. Maintain, modify, install, integrate, and test the ECS software;
- c. Maintain, diagnose, install, integrate, and test the COTS software;
- d. Install, integrate, and test investigator software; and
- e. Maintain portability among ECS COTS and developed applications software, databases, tables, and other operations software.

The Contractor shall develop and implement a COTS Maintenance Plan (DID 613/OP1 (P), | CN04 613/OP1 (F)) prescribing policies and procedures to be applied to maintenance of hardware, firmware, and software for which the Contractor has M&O responsibility. The hardware, firmware, and software shall be maintained according to this plan. The plan shall delineate the Preventive Maintenance (PM) for systems/equipment and provide a means for scheduling its accomplishment; provide a system of records to document maintenance, including both PM and corrective maintenance, as well as modifications; specify reports to be provided; provide procedures for configuration control; and specify training requirements and schedules.

The Contractor shall develop preventive and corrective maintenance procedures using STDN 402, System Maintenance Program, as a guideline. The Contractor shall include any state-

of-the-art techniques that are developed and/or applicable to the ECS. Hardware maintenance procedures shall conform to NASA, GSFC, and/or other Government agency safety standards.

The Contractor shall develop and document in the COTS Maintenance Plan^{CN04} (DID 613/OP1(P), 613/OP1 (F)) policies and procedures for maintaining visibility and control of system problems using discrepancy reports or similar mechanisms. The same policies and procedures shall be applied to COTS hardware or software.

The Contractor shall maintain an ECS hardware, software, and firmware documentation library consistent with the needs at each of the ECS sites. This activity shall include the updating or procurement of ECS-related documents (schematics, user or technical reference guides, maintenance manuals, etc.) whenever ECS hardware, firmware, or software is modified or replaced. Updates to documents shall be made in accordance with configuration management procedures.

Facility layout of equipment and work areas including power, electrical, and air conditioning requirements shall be provided and maintained. Installation, administration, and maintenance guides shall be provided for each type of processor, software tool, and application.

The Contractor shall utilize trained and certified M&O personnel to maintain the ECS hardware, firmware, software, and supporting equipment. The Contractor shall provide maintenance subcontracts as needed with vendors of ECS hardware and software. The Contractor shall maintain software licenses with software vendors, the receipt of updates, new releases, etc. The phase-over of maintenance to the successor maintenance contractor shall include the transfer of system and site documentation, test equipment, test tools, site licenses, and related materials.

3.8.3.2.1 Sustaining Engineering

The Contractor shall provide a sustaining engineering function (hardware, software, and firmware) that shall identify and, when directed and approved by the Government CCB, implement needed improvements to the current operational version of the hardware, software, and firmware. These improvements will be identified by science users, operations personnel, the Project, and through analyses and evaluation of ongoing system operations by the sustaining engineering organization. The sustaining engineering function shall include the analyses and identification of ways to accommodate new technologies and new concepts, manage system

upgrades and evolution, control and maintain ECS databases, and perform the activities necessary to ensure ECS reliability, maintainability, and availability.

Changes are subject to the configuration management policies and procedures defined in the ECS Configuration Management Plan (DID 102/MG1). The improvements shall be documented and incorporated into subsequent ECS system releases in accordance with the configuration management policies and procedures as part of the ongoing ECS implementation activity.

The sustaining engineering effort shall include, but not be limited to, installation, configuration, and tuning of the ECS software, COTS packages, operating systems, compilers, tools, utilities, networks, and databases.

3.8.3.2.2 Hardware Maintenance

The Contractor shall implement a hardware maintenance program that complies with the ECS availability and performance requirements. Hardware maintenance shall be conducted at each site at a minimum of two levels. First-level maintenance shall be conducted to support the ECS availability requirements by replacement of line replaceable units (LRUs). LRUs include printed circuit cards or other plug-in components, rack-mounted equipment drawers and panels, or other assemblies which can be removed by unplugging power and signal connectors without physically disturbing other LRUs.

Second-level maintenance shall be conducted to restore malfunctioning equipment to serviceable condition when the failure requires unit/element disassembly. Second-level maintenance shall also be required when the fault isolation capabilities of first-level maintenance are incapable of localizing a failure to a line replaceable item within an LRU. Second-level maintenance shall consist of the repair, adjustment, and testing of LRUs removed from service during first-level maintenance actions.

The Contractor shall provide general and special test equipment and other resources to support maintenance of ECS systems and subsystems at all sites. Special maintenance and test equipment shall be used only if COTS equipment is unavailable. The Contractor shall provide a List Of Recommended Maintenance Equipment in accordance with DID 619/OP3 covering|CN04 standard and special equipment required for maintaining and testing the equipment before it is returned to operational service. The Contractor shall provide Special Maintenance and Test Equipment in accordance with DID 615/OP2 documentation.

3.8.3.2.3 Software and Firmware Maintenance

The Contractor shall provide for complete software and firmware maintenance, including activities associated with producing, delivering, and documenting the corrections, modifications, and enhancements made to ECS software (including COTS) and firmware, and/or to adapt any COTS software for ECS use. The software and firmware maintenance activities shall include the maintenance and control of software and firmware documentation and configuration management, including change control, configuration status accounting, and quality assurance.

The Contractor shall develop a Developed Software Maintenance Plan in accordance with|CN04 DID 614/OP1 and maintain ECS software (including COTS) and firmware in accordance with the policies and procedures specified in that plan and in the ECS Configuration Management Plan (DID 102/MG1).

The Contractor shall provide resources, including dedicated equipment and software tools and personnel to perform software and firmware maintenance, testing, and validation to maintain ECS functional, performance, and availability requirements. These resources and plans and a history of maintenance actions shall be provided to the successor contractor.

The Contractor software/firmware maintenance activity shall include services required to produce, deliver, install, test, and document corrections and modifications of existing ECS software and firmware. The maintenance activity shall include software/firmware CM, including change control, configuration status accounting, and software/firmware QA and shall provide software tools for the automation of these functions, including the reporting associated with these functions.

The Contractor shall provide the capability for integration, system testing, and validating ECS software and firmware.

The Contractor shall provide for maintenance of ECS software and firmware final design source code, executable code, and operational versions thereof.

3.8.3.3 Operations

The Contractor shall operate the ECS elements and supporting equipment with trained and certified M&O personnel. The Contractor shall supply sufficient technical and professional support personnel to provide the scientific community with the required assistance in the use of the ECS facilities. The Contractor shall generate and distribute data products in accordance with the system functional and performance specifications and provide system-wide reporting and accounting of operations activities.

The Contractor M&O organization shall provide management staff to perform tasks that include planning, budgeting, accounting, resource management, customer relations, scheduling, and personnel. The Contractor M&O organization shall also provide an operations staff to perform tasks that include the operation of computers and peripheral devices, data and product quality checking and accounting, librarian, and media dispatching, delivery, shipping, disposition and reporting.

3.8.3.3.1 Flight Operations

Flight operations support shall be centralized at the GSFC with interfaces to the external institutional facilities, and the international partner ICCs (for instruments/payloads on the U.S. spacecraft). The Contractor shall staff the FOT located at GSFC FOS. The FOT shall provide mission operations support with technical directives from the NASA MOM and the EOS Project Scientist and/or his deputy provided as necessary. Coordinated spacecraft planning, scheduling, and commanding operations shall be performed by the FOT in accordance with the MOM's policy guidelines and directives. Instrument science planning and scheduling operations, including conflict resolution, shall be performed under the general high level direction and guidance of the Project Scientist or his deputy.

The ECS EOC and ICF shall be operationally ready one year prior to an EOS spacecraft launch.

The Contractor's FOT shall perform operations required at the FOS to ensure that the ECS|CN01 flight segment achieves the functional and performance requirements of the ECS Specification. These functions include operation of the DAR processing service, the planning and scheduling service, command management service, commanding service, telemetry processing service, spacecraft and instrument monitoring and analysis service, data management service, element|CN02 management service, and user interface service. The Contractor shall also monitor system performance and perform the fault detection and isolation function.

The Contractor shall coordinate with the spacecraft contractor for functions associated with the|CN02 spacecraft simulator and spacecraft analysis tools.

The ECS shall provide flight operations support 24 hours a day, seven days a week. The|CN01 FOT shall provide support to external operational interfaces, and the international partner equivalent flight operations and data handling/ processing systems.

The FOT shall include sufficient technical and professional support personnel to provide the scientific community with needed assistance in the use of the EOS flight operations systems.

The FOT shall provide timely, accurate, and reliable operations support for command and control of the spacecraft and instruments. Spacecraft and instrument safety shall be the overriding|CN02 factor in flight operations.

Lead responsibility for the operations of a spacecraft will initially be provided by the spacecraft contractor to support launch, starting with a trained and certified core staff at approximately launch minus six months (L-6) through launch plus three months or until satisfactory checkout of the spacecraft and instruments whichever is later. The ECS Contractor shall coordinate and cooperate in flight operations training for the spacecraft contractor. The ECS Contractor shall support the transition of operations from the spacecraft contractor to the ECS Contractor and assume full operations responsibility at approximately three months after a launch. The ECS FOT and the spacecraft contractor FOT shall provide integrated and cooperative operations support through launch plus approximately 3 months. The ECS Contractor shall have the lead responsibility for performing instrument operations after the instruments have been initialized and checked out. This responsibility will be exercised in coordination with the spacecraft contractor and the instrument teams. The ECS Contractor shall support the transition of flight operations from the ECS Contractor to the successor contractor prior to the expiration of the ECS contract.

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3.8.3.3.2 Science Data Processing Operations

At each DAAC site, the ECS Contractor shall provide the science data processing operations consisting of the archiving, processing, and information management functions for which it developed the software, hardware, and procedures. The DAAC sites shall also host elements of the distributed SMC and ESN, with coordinating SMC and ESN elements located at GSFC. The science data processing operations, shall accept high level direction and guidance from the SOM.

The Contractor shall provide staff and resources required to achieve required functional and performance capabilities of the ECS science processing segment. The DAAC sites shall be operated 24 hours a day, 7 days a week.

The product generation activities, including processing, reprocessing, ingestion, archiving, and distribution shall be scheduled, monitored, controlled, reviewed, dispatched, and managed by the Contractor's operations staff using the developed ECS capabilities.

The Contractor shall provide product distribution, archive maintenance, systems support, and data housekeeping activities (such as data backup recovery functions).

The Contractor shall provide a Technical Assistance Group (TAG) to assist in access to and use of the ECS, to address user needs (including systems registration, general inquiry, product request, logistics, user accounting, and product acquisition and tracking), and to aid in the use and development of: metadata, subsets of data, numerical methods and tools, vector and parallel processor techniques, visualization and graphics tools, analysis tools, expert systems, data formats, and computing techniques. This organization shall also support the scientists in testing and integrating their new and modified product generation algorithms into the production environment on the PGS.

3.8.3.3.3 Communications and System Management Operations

3.8.3.3.3.1 Network Operations

The Contractor shall provide staff and resources required to achieve specified ECS network functional and performance capabilities. Network operations shall be provided as a central network management facility at GSFC with supporting operations at all ECS sites, as required. The Contractor shall coordinate operations with external network management and operations organizations including those for Ecom, institutional networks (e.g., PSCN), public networks|CN02 (NSI), private networks, SCFs, ADCs, ODCs, and IP networks.

The Contractor operations staff shall provide network management functions including planning, performance monitoring, fault detection and isolation, configuration management, reporting, security, and directory and accounting services.

The Contractor operations shall provide network user's support services. Users of the ECS networks will include members of the science community, the EOS Project, ECS operators, SCF, ADC, and ODC operators, sustaining and maintenance organizations, science algorithm developers, and the ECS development team.

3.8.3.3.3.2 Systems Management

The Contractor shall provide staff and resources required to achieve required functional and performance capabilities of the ECS SMC. System management for ECS shall be performed via the SMC located at GSFC.

The SMC operations shall receive high level direction and guidance from the ESDIS Project. |CN02
The SMC operations shall execute the EOS mission/science policies, procedures, and directives as well as the ESDIS Project policies, procedures, and directives. The SMC operations monitors |CN02 the implementation of and adherence to the aforementioned policies, procedures, and directives.

The SMC operations shall perform high-level scheduling, configuration management, performance management, fault management, security management, accounting/accountability, and directory services.

3.8.3.4 Training and Certification

The Contractor shall provide hardware, software, and operations procedure training in at least the following areas:

- a. User training;
- b. Investigator training;
- c. Government manager orientation training;
- d. Operator training for both equipment operations and mission operations;
- e. Maintenance training for ECS hardware, software, and firmware;
- f. ECS security procedures.

The Contractor shall conduct training as necessary during the life of the contract. The training shall be provided, but not necessarily limited, to the following:

- a. The spacecraft contractor FOT; |CN02
- b. Users of the ECS, including project personnel, investigators, and instrument teams;
- c. ECS M&O personnel;
- d. Successor contractor personnel;
- e. IV&V personnel;
- f. Government management and technical personnel;
- g. DAAC M&O personnel.

The Contractor shall augment user services during release transitions to provide additional support to users. The schedule of operations during release transitions shall be coordinated so

that users do not experience disruption in services or planned activities. The Contractor shall inform users in advance of release upgrades modifications and schedules. The Contractor shall provide technical assistance support to users.

The Contractor shall provide training for systems and equipment delivered under the ECS contract. The training program shall be accomplished in accordance with the provisions of the Contractor Provided Training Specification (535-TIP-CPT-001). Training policies, plans, and procedures shall provide for an orderly phased transition from initial ECS operating capability through full operating capability into sustained operations and maintenance. ECS training shall prepare EOS personnel, both Government and Contractor, to operate, maintain, and utilize the ECS in the support of EOS missions. ECS training shall include courses in security procedures for ECS operations personnel. For ECS maintenance personnel, ECS training shall include maintenance procedures that support the ECS maintainability and reliability requirements. Training shall be conducted at GSFC and other locations.

The Contractor shall deliver instructor and student training courses and material for use in ongoing refresher and new hire training for Government/user/contractor personnel during the operational life of the ECS contract. The courses and materials shall be updated as necessary to reflect changes to the ECS. The Contractor shall provide training devices, equipment, software, administrative, and facilities support to implement the training program.

M&O positions encompassed by this contract shall require certification that assignees meet standards at an acceptable level of competence before permanent assignment is made. The capabilities required may be obtained by suitable recruiting measures, but many unique factors require formal and/or on-the-job training. The method of training selected shall be based upon the lowest cost per trainee, but shall ensure that performance standards are not compromised. General training shall not be provided under this contract by the Contractor since personnel should have accomplished such training prior to assignment to this contract. Types of training to be provided include:

- a. Formal Training
Classroom and laboratory-based training classes that follow instruction plans developed for each course and include written or oral examinations to ensure that the required material has been learned by the students.
- b. On-the-Job Training
Proficiency in the operating positions shall be gained primarily through on-the-job training (OJT). Operations instructions and other Contractor-developed or Government-approved

documentation and procedures shall be used in providing OJT. Trainees shall be required to perform specified tasks satisfactorily, give adequate response to prepared written or oral questions and work under a certified operator for a specified time to complete OJT. Periodic refresher courses covering security procedures shall be given to ECS operations personnel.

c. Self-Study Courses

Self-study courses shall be developed and used to supplement formal training courses and prepare ECS M&O personnel for certification testing. Courses shall be short in duration (less than 1 week) and used where the instructional strategy lends itself to a self-study format. They may be used to provide prerequisite training prior to formal or OJT training.

d. Vendor Training

Vendor training courses for ECS equipment shall be provided to ECS Contractor personnel, IV&V personnel, Government technical personnel, and spacecraft contractor operations personnel, as applicable. The ECS Contractor shall prepare a plan for distribution of vendor training from vendor training credits and from purchased training. This plan shall be submitted to the CO/COTR for review and approval. |CN02

e. Cross-Training

Cross-training may be used for training of persons already certified in one position to prepare them for certification in another position. Cross-training will be a combination of other types of training and shall be tailored to avoid duplicating training in knowledge or skills already possessed by the trainee.

3.8.3.4.1 Certification Program

The ECS M&O certification shall ensure that an acceptable level of proficiency is achieved by personnel prior to being assigned to work in defined operations or maintenance positions. The Contractor shall produce an M&O Certification Plan in accordance with DID 626/OP1 for CO/COTR approval, designed to ensure that acceptable levels of proficiency are achieved by ECS maintenance and operations personnel. The plan shall include the procedures and examinations which shall be required to achieve certification for each operations or maintenance position.

3.8.3.4.2 Development of Training Material

In accordance with the ECS Training Plan in accordance with DID 622/OP2, the Contractor shall define the types of training to be performed, training class plans, student requirements, and similar material. The Contractor shall determine the total ECS maintenance and operations training requirements and provide an overview for each ECS element.

The Contractor shall provide the Training Material (DID 625/OP3), as approved by the CO/COTR, needed to administer the training courses for each ECS element. ECS training material and equipment shall be prepared or otherwise provided in accordance with Contractor Provided Training Specification (535-TIP-CPT-001). The course material shall be modularized and individualized, and shall use multimedia learning resources including manuals, study guides, workbooks, audio-visual materials, and interactive computer-aided instruction and/or computer based training. Training documentation shall be developed and configured to be compatible for direct electronic interface/interchange with the Standard for Automated Interchange of Mission Operations & Data Systems Directorate Technical Information 500-TIP-2601.

The Contractor shall provide science user/investigator on-line training. A Science User's Guide and Operations Procedures Handbook shall be developed in accordance with DID 205/SE1 to enable remote users to access ECS Services by signing-on from terminals at their home institutions.

3.8.3.4.3 Conduct of Training

The Contractor shall provide training using the training plans and training material developed for this purpose. The major objective in training shall be the preparation of M&O personnel for becoming certified in operations and maintenance positions and the preparation of users of the ECS to effectively utilize the system. In this context, "users" include science investigators or operators of other non-ECS EOSDIS elements who will interface with or directly utilize the ECS.

During the development phase of the ECS, preliminary training courses shall be conducted to prepare Government, IV&V contractor, ECS Contractor, and other personnel for integration and test of the ECS. The curriculum of the preliminary training courses may be different from that of subsequent M&O training courses. The Contractor shall make student positions in vendor training courses available to Government, IV&V contractor, and other personnel to supplement the preliminary training courses.

As a minimum, the following training courses shall be provided:

a. Preliminary Training Courses

A preliminary training course for Contractor M&O personnel, for IV&V personnel, for Government technical and contract support personnel, and for spacecraft contractor operations personnel shall be conducted at the Contractor's facility early in the integration and test phase of the contract. This training course shall prepare these persons to assist in subsystem and system tests and perform the maintainability demonstrations. Additional preliminary training courses shall be conducted prior to installation of new Releases and shall be conducted on-site at the ECS facilities where the new Release will be installed. | CN02

b. Vendor Training Courses

The Contractor shall arrange training courses to be conducted by vendors of COTS hardware and software, where the vendors offer such training as a standard product. The ECS Contractor shall make available positions for Government technical and IV&V personnel for hardware and software training on purchased equipment at the vendor's facilities or other location agreeable to the CO/COTR.

c. Final M&O Training Courses

Final M&O training courses shall be conducted as necessary to provide trained and certified Contractor personnel for those positions for which the Contractor has M&O responsibility. Training shall also be conducted by the Contractor at the facilities prior to the transition of M&O responsibility to the permanent M&O contractor at each facility. A copy of training material shall be provided for retention and use by the facility and the permanent M&O contractor.

d. Science User Training

Science user training shall be conducted as necessary to familiarize science users with ECS services, the interface software toolkits provided, and increased capabilities available in new ECS releases. As a minimum, the Contractor shall provide this training at the DAAC sites.

e. Training for spacecraft flight operations personnel

Training for spacecraft flight operations personnel shall be provided as stated elsewhere in this SOW. | CN02

3.8.3.5 Planned Upgrades

The ECS Contractor's M&O organization shall support and participate in planning and implementation of upgrades to the ECS. These upgrades may be the result of:

- a. Installation of planned system capacity growth for increases in computational power, data storage capacity, communications capacity, etc.;
- b. Installation of system capacity expansion required due to growth of system capacity requirements beyond original performance estimates;
- c. Replacement of obsolete, out-of-date equipment, unacceptably expensive to maintain identified by the Annual Capabilities, Requirements, and Technology Report (DID 204/SE3);

- d. New releases of COTS.

System upgrades shall have minimal impact on applications and tools. Upgrades will be done as approved by the CO/COTR.

The Contractor shall provide planning for upgrades and shall support the CO/COTR's review of the need for the upgrade and the plans for implementation of the upgrade. The Contractor shall procure the hardware and software called for in the planned upgrade and shall perform or support the installation and testing of the upgrade. The Contractor shall update documentation affected by the upgrade, including but not limited to:

- a. Facility plans and floor plans;
- b. Operations plans and procedures;
- c. System documentation and users guides;
- d. Training materials.

Upgrades shall be coordinated with the affected operational sites to ensure proper facility planning and preparation including floor space, power, and air conditioning. Upgrades shall follow applicable configuration management procedures, integration and test procedures, and formal acceptance testing procedures. The Logistics Support Analysis Plan shall be updated.

PRELIMINARY FLOOR PLAN FOR GSFC EOSDIS FACILITY

Available in Hardcopy only.

APPENDIX B

ELECTRICAL AND MECHANICAL REQUIREMENTS FOR GSFC EOSDIS FACILITY

B.1 Floor Space and Allocation

B.1.1 General

The EOSDIS facility consists of three floors of approximately 65,000 sq.ft. per floor, plus a penthouse for mechanical and electrical equipment. The ADP equipment and data storage areas are allocated as follows:

Ground Floor	—	Data Archival
First Floor	—	Product Generation
Second Floor	—	Flight Operations

with Project and ECS M&O personnel space also allocated on each floor.

B.1.2 Raised Floor Systems

The following areas are provided with a 36"-high computer raised floor system:

Ground Floor

Archive area — 10,800 sq.ft.

Disk farm & controls — 14,400 sq.ft.

1st Floor

Computer area — 21,600 sq.ft.

(between column lines 1C & 7G of the 1st floor Preliminary Floor Plan)

2nd Floor

Computer area — 21,600 sq.ft.

(between column lines 1C & 7G of the 2nd floor Preliminary Floor Plan)

The following building systems are located under the computer raised floor system:

- a. Chilled water lines and electrical power supply cables serving the computer floor mounted A/C units;

- b. Fire protection and detection systems;
- c. Water detection system;
- d. Chilled water loop dedicated for computer heat exchangers (if required);
- e. Space is provided with drains and drain piping.

B.1.3 Ceiling Space

Space above the accessible dropped ceilings in all areas of about 60 inches contains the customary building systems (HVAC, ducts, chilled water, steam and hot water piping, sprinkler, piping, conduits for lighting and fire detection systems, power feeder, cable trays, etc.).

B.1.4 Electrical & Communication Closets

At the perimeter of each computer raised floor area, several 8' x 10' Electrical Closets (E) and 5' x 10' Communication and Data Closets (T) are located. These closets are designated by (E) and (T) on the floor plans and are provided with direct access to the computer raised floor system.

B.1.5 Communication & Data Raceways

The Communication & Data Closets (T) are interconnected by a 24 inch wide, 4 inch deep cable tray system which is installed above the accessible ceilings and looped around from closet to closet. In addition, the 24 inch cable tray loop is interconnected horizontally by 18 inch cable tray networks.

The Communication & Data Closets are vertically stacked and are interconnected with 5 inch sleeves. In addition, the Ground, First, and Second floor areas are interconnected with six (6) vertical 18 inch cable trays at the intersection of the column lines 3D, 6D, 3F, 6F, 43, and 5E. (NOTE: Cable trays under the raised floor system are not provided by the building contractor.)

The Communication Main Service Room of about 1500 sq.ft. is located on the Ground Floor and is interconnected with 4 inch conduits to the Communication & Data Closets (T).

B.2 Electrical Building Services

Secondary electrical building service is rated at 480Y/277 volts, 3 phase, 4 wire, 60 Hz and 208Y/120 volts, 3 phase, 4 wire, 60 Hz. Power switchgear for both voltage services are located in the Ground Floor and Penthouse.

B.2.1 Grounding System

In addition to the building ground, a dedicated and separate grounding system is provided with terminations located in the Electrical Closets at the intersection of column lines 2C, 6C, 3G, and 7G on the First and Second Floor and 3G, 7G, and 6C on the Ground Floor.

B.2.2 Electrical Power Connections to ADP Equipment

The building power switchgear dedicated to serve the Ground and First Floor ADP equipment is located on the ground floor (Electrical Vaults #1 & #2) and is rated 480Y/277 volts, 3 phase, 4 wire, 60 Hz for possible ADP power requirements and is rated 208Y/120 volts, 3 phase, 4 wire, 60 Hz for data archival ADP. The building power switchgear dedicated to serve the Second Floor ADP equipment is located in the electrical vault on the Penthouse (Electrical Vault #4) and is rated 208Y/120 volts, 3 phase, 4 wire, 60 Hz. Draw-out circuit breakers of adequate capacity and number is provided at the building power switchgear.

All electrical work shall be in accordance with applicable codes and NASA requirements.

B.2.3 Uninterrupted Power Supply (UPS) Systems

The UPS and UPS switchgear (as required) will be located in a vault located on the Ground Floor (UPS Vault #1) for Ground Floor and First Floor systems and in the Penthouse (UPS Vault #2) for Second Floor systems.

B.2.4 Emergency Power (Diesel) to ADP Equipment

The building power distribution system has been segregated into two major branches:

- a. Non-essential load branch;
- b. Critical load branch.

Equipment that is designated for real-time operation will be connected to the critical load branch as directed.

B.3 Mechanical Services

B.3.1 HVAC System

The building HVAC system consists of overhead air distribution providing comfort conditioning, the required fresh air changes, and humidity control.

The computer raised floor areas are provided with a chilled water distribution loop which will serve floor mounted, chilled water computer room units for supplying conditioned air to the underfloor plenum. The chilled water distribution loop and the floor mounted computer room units will be furnished and installed by the building contractor.

In addition, dedicated chilled water loop of adequate capacity is provided under the raised floor system of the First Floor for providing service to any water cooled super-computer class systems. The chilled water system varies between 42° to 54° F supply temperature.

The Data Archival area is served by an overhead building air distribution system to maintain 72° F and 50% relative humidity.

B.3.2 Space for Mechanical/Electrical Equipment Supporting the ADP and Data Storage & Retrieval Systems

Adequate space is provided in the UPS Vaults and the Electrical and Telephone Closets to install any mechanical/electrical equipment provided by the ECS Contractor as well as mechanical/electrical equipment provided by the building contractor; however, the ECS Contractor shall coordinate with the CO/COTR the equipment physical space requirements in the vaults and closets and install such equipment as directed.

B.3.3 Chilled Water Service to ADP Equipment

All internal ADP cooling systems shall be provided by the ECS Contractor.

A building source of chilled water varying between 42° to 54° F supply-temperature which provides condenser cooling for 1st Floor ADP refrigerating devices, if required, is provided by a dedicated chilled water loop under the raised floor. The building-dedicated chilled water loop

under the raised floor can be tapped to provide all interconnecting piping, valves, pumping, and controls for connection to the computer cooling equipment.

Equipment-room space cooling is provided by the building floor-mounted computer room A/C units with chilled water coils, fans, and controls for discharging cooling air to the underfloor plenum. The location and number of the building-provided, computer room A/C units in each ADP area will be as directed by the ECS Contractor to maintain the required space conditioning.